



# La transformation du système bancaire dans l'Union européenne : une approche en terme de réseaux

Lyubomir Mirchev

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NICE SOPHIA ANTIPOLIS UNIVERSITY

Ecole Doctorale DESPEG

***TRANSFORMATION OF THE BANKING SYSTEM IN THE EUROPEAN  
UNION: A NETWORK APPROACH***

Dissertation for the “Doctorat en Sciences Economiques”

presented and defended by

LYUBOMIR MIRCHEV

5 November 2013

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UNIVERSITE NICE SOPHIA ANTIPOLIS

ECOLE DOCTORALE DROIT ET SCIENCES POLITIQUES  
ECONOMIQUES ET DE GESTION  
ED DESPEG

***LA TRANSFORMATION DU SYSTEME BANCAIRE DANS L'UNION  
EUROPÉENNE :  
UNE APPROCHE EN TERMES DE RÉSEAUX***

Thèse de Doctorat en Sciences Economiques,  
présentée et soutenue par  
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## **Introduction**

### **Relevance of the problem**

In recent years, financial markets worldwide became highly integrated, overcoming national borders. The problem of developing adequate tools and comprehensive approaches for achieving higher security and stability in the EU financial sector is on the agenda. Key issues and challenges for the formation and development of the single European financial market, driven by the new realities, are considered in this thesis. The need for transformation of the European banking market is analyzed regarding the challenges, which the crisis brought to the banking system - especially in terms of its social function as a key intermediary in the economy. In this context, innovative approaches are proposed in the dissertation for analysis and regulation of the banking markets aiming to improve the system's stability and efficiency.

### **Goal and objectives of the thesis**

The goal of this thesis is to propose and develop analyses able to contribute to the transformation of the banking system. The current state of the system is a structure with delayed-in-time management. In this system, the impact of the regulatory measures and interventions in response to a particular problem is delayed in the time due to the structure of the market and the periodicity of information gathering. The Aim of this dissertation is to transform the system into an operational self-regulating system (system of systems) operating in near real-time. This transformation would allow sharp increase in stability and operability of the system.

The so defined goal implies the following more specific objectives:

- to analyze the banking market through the network perspective in order to reveal some aspects of the system, not typical to the particular institutions, regarded

as separate entities, and for contributing to the solution of the major problems in the banking sector;

- to analyze the regulatory and supervisory architectures for discovering the current control structure of the banking system;

- to explore and develop the architecture of the banking system as a separate critical infrastructure, which could enable the application of network-centric approach as an opportunity for achieving stability and efficiency (operability) in the financial sector, directly related to national and international security.

To achieve the main goal, the following practical approaches have been proposed:

- an analysis of the Bulgarian banking market development and its integration in the process of transition to a single European financial market. We apply at this stage an unconventional but effective parametric frontier method DEA (Data Envelopment Analysis);

- a comparative analysis of national supervisory and regulatory architecture in the EU, and an analysis of the opportunities of their institutional development in relation to the construction of the single European financial market in times of crisis;

- a mathematical modeling and simulation study of the behavior of the banking system as a network infrastructure under financial stress and the distribution of this shock in the system;

- an extension of the scope of the critical infrastructure in the financial markets by considering the banking system as a separate high-level critical infrastructure, which builds on the concept of traditional critical infrastructures (predominantly mechanical/communicational infrastructures) by combining them using economic models;



- the development of innovative tools to transform the banking system and for achieve high level of stability and efficiency of the economic and financial system as a whole;

- the inclusion of bank regulation and supervision, as a key element in a self-synchronizing network on a supranational level.

## Research thesis

The research thesis of this dissertation is the need and the possibility of transformation of the banking system for achieving decisive operability and stability based on the introduction of concepts related to the network approach and treating the system as a critical infrastructure.

## Approaches and methods

In connection with the defined goal and for solving the research thesis, in the dissertation is applied theoretical methods like mathematical models, simulation modeling and systemic approach under which the analyzed object is regarded as a system with defined elements and internal and external connections, which influence the functioning of the system. The systemic approach is deemed as the most robust foundation for management of complex interconnected activities, which allows the discovery and analysis of the different elements and their dependence.

The dissertation employs also an architectural approach, which allows the representation of a clear picture of an object or a system, such as of a specific function of a system. This approach gives a fixed description of the functional interdependencies in the system under the form of models. The main goal of the architectural approach is to optimize the interdependencies and internal interactions in the system by creating an appropriate infrastructure.

A comparative and Data Envelopment Analysis (DEA), are employed also. The use of network-centric and multi-agent approaches is proposed for protection of the

critical banking infrastructure and the creation of a supranational network supervisory architecture.

The network-centric concept is based on the principle of self-synchronization specific to the theory of complex systems. The essence is that complex phenomena and structures are best organized bottom-up. The agent-based modeling is a powerful simulation modeling technique that has seen a number of applications in the last few years, including applications to real-world business problems (Bonabeau, 2002). It is a method for studying systems, which are composed of interacting agents and which shows properties, stemming from the interactions of the agents that cannot be drawn simply by aggregating the individual agents' properties.

## Practical application

The results of the practical realizations and theoretical concepts in the thesis can be useful for both bank managers and the supervisory and regulatory authorities in their efforts for improving the financial and banking activities.

Based on the developed mathematical modeling and simulation of the banking system, a software has been realized for testing the behavior of the banking system in a state of financial stress and its distribution between interconnected banks.

## Main results

Key practical and theoretical contributions in the thesis:

- The main proposition of the thesis is the creation of a new type of network supervisory architecture as an alternative to the current supervisory models in order to respond to the modern structure of the financial markets.
- Other propositions concern methodology. The thesis innovates in proposing:
  - an extension of the scope and the means for action in Crisis response operations (CRO) with operations for stabilizing the banking system in times of

financial crisis with the establishment of integrated (internationally) joint financial supervisory structures;

- an application of critical infrastructures paradigm while accounting for the vulnerability of the banking system;

- an introduction of simulation modeling for achieving network-centric multi-agent architecture for critical interdependent banking structures;

- a conceptual dynamic model of the banking system as part of the overall system for security and stability.

- Software modules are developed for simulation modeling of the behavior of the banking system as a network structure, in which financial stress is spreading.

- It is applied an unconventional but effective approach to assess and compare the efficiency of Bulgarian and foreign banks based on the DEA method (Data Envelopment Analysis).

## Acknowledgements

I would like to express my gratitude to Professor D. Torre and Professor N. Nenovski - my PhD supervisors, whose guidance, efforts and patience contributed significantly for the realization of this thesis. I would like to thank also to the management of the two universities (UNICE and UNWE) and to the francophone initiative College Doctoral, which gave me the opportunity to participate in many international seminars and fora. Very special thanks go to Professor Velina Slavova, without whose motivation and expertise, the simulation model would have been very difficult to achieve.

## Actualité du problème

Ces dernières années, l'intégration des marchés financiers s'est accrue dans le monde entier. Ces marchés dépassent désormais les frontières nationales. A l'ordre

du jour, la création d'instruments financiers adéquats et une démarche nouvelle, destinée à améliorer la sécurité et la stabilité du secteur financier de l'UE. L'objet de cette thèse est d'appréhender les principaux problèmes posés par la constitution et le développement du marché bancaire européen, et d'identifier les défis engendrés par les nouvelles réalités qui lui sont associées. Ce travail examine la transformation du marché bancaire européen, impacté par la crise, en mettant l'accent sur sa fonction de coordination dans l'économie. Les méthodes employées sont à la fois diversifiées et innovantes, adaptées à un objet que les phases d'instabilité financière de la dernière décennie ont rendu pertinent.

### Objectifs de la thèse

L'objectif de la thèse est d'analyser la transformation du système bancaire, d'une structure à effets différés, - c'est à dire telle que les mesures de régulation et les interventions en réponse à un problème sont différées dans le temps -, en un système opérationnel d'autorégulation fonctionnant en temps réel. Cette transformation améliorerait radicalement la stabilité et l'efficacité du système dans son ensemble.

Cet objectif général conduit aux étapes suivantes :

- analyser le marché bancaire à travers une analyse du réseau pour mettre en évidence certaines spécificités des liens institutionnels, et contribuer ainsi à l'analyse de la transformation du secteur bancaire ;
- identifier les architectures de régulation et de contrôle du système bancaire pour mieux identifier sa structure actuelle de gestion et de contrôle ;
- appréhender le système bancaire comme une infrastructure critique relevant d'une approche en termes de réseau, et analyser ses propriétés de stabilité et d'efficacité dans le domaine financier (bancaire), d'un point de vue national et international.

Les approches suivantes seront menées :

- une étude du développement du marché financier bulgare et de son intégration dans le processus de transition vers le marché financier européen unique, sont réalisés par le biais d'une approche non-paramétrique de détermination de la frontière d'efficacité (analyse d'enveloppement des données) non conventionnelle mais efficace – la méthode DEA (Data Envelopment Analysis) ;
- une analyse comparative des architectures nationales de contrôle et de régulation dans l'UE, et de leur mise au point dans le cadre d'analyse des problèmes de construction du marché financier européen unique en temps de crise
- une modélisation mathématique et par simulation numérique avec l'objectif d'étudier le comportement du système bancaire en tant qu'infrastructure de réseau, subissant l'influence de chocs financiers qu'il diffuse dans l'économie ;
- le traitement du système bancaire comme une infrastructure critique indépendante, de plus haut niveau, construite sur la base d'une conception des infrastructures critiques traditionnelles (avant tout des infrastructures mécaniques/ de communication), en les combinant et en utilisant des modèles économiques ;
- une réflexion sur les moyens à mettre en œuvre pour transformer le système bancaire et améliorer la stabilité et l'efficacité du système économique et financier ;
- la prise en compte d'éléments de régulation et de contrôle bancaires par le biais d'un réseau international auto-synchronisé

## L'idée défendue

La thèse met en évidence la nécessité mais aussi la possibilité d'une transformation du système bancaire, dans un objectif d'efficacité et de stabilité. Les éléments de cette transformation sont apportés par une approche en termes de réseau et par un traitement du système bancaire en tant qu'infrastructure critique.

## Les approches utilisées

En relation avec l'objectif fixé, la thèse recourt à une la modélisation mathématique, la simulation numérique, l'approche systémique. L'approche systémique est une approche permettant d'identifier les invariants d'activités complexes et interdépendants et de découvrir ou d'analyser les différents termes de leurs relations.

L'analyse comparative et l'analyse DEA sont aussi appliquées. Des approches réseau-centrique ou du type multi-agents sont proposées aussi, dans l'objectif de protéger l'infrastructure bancaire critique et de créer une architecture de surveillance réseau-centrique supranationale.

L'analyse en termes de réseaux est basée sur le principe d'auto-synchronisation, spécifique à la théorie des systèmes complexes. Selon cette conception, les phénomènes et les structures complexes sont mieux organisés par une approche descendante. La modélisation multi-agents est une technique de simulation dont la pertinence est aujourd'hui reconnue en économie. Elle s'applique notamment à l'étude de contextes dans lesquels les interactions sont essentielles, de telle sorte qu'une simple agrégation des propriétés des différents agents ne saurait suffire à les approcher.

## Les applications pratiques

Les résultats de la thèse fournissent des éléments de réflexion aux professionnels de la banque, aux autorités de régulation et de contrôle, aux décideurs publics.

Un logiciel d'étude du comportement du système bancaire en situation de diffusion d'un choc financier entre banques en interaction a été réalisé dans le cadre de la thèse, produit joint de la modélisation mathématique et de l'étude de simulation du réseau bancaire.

## Les résultats principaux de la thèse

- L'apport principal de la thèse est de fournir un modèle de surveillance en termes de réseaux, ce qui constitue un nouveau type d'architecture de contrôle du réseau financier. Ce modèle fournit une alternative aux modèles de contrôle actuels, dans l'objectif d'appréhender la structure contemporaine des marchés financiers.
- Les autres contributions ont un caractère méthodologique. La thèse utilise des approches innovatrices. Comme,
  - l'extension du champ d'application et les moyens d'action dans les opérations de réponse aux crises avec les opérations de stabilisation du système bancaire en temps de crise financière avec la mise en place des structures intégrées (internationalement) de contrôle financier conjointes;
  - l'application du paradigme de l'infrastructure critique lors de la détermination de la vulnérabilité du système bancaire ;
  - l'introduction de la modélisation et de la simulation numérique pour appréhender une architecture en termes de réseaux pour les structures bancaires critiques interdépendantes ;

- l'élaboration d'un modèle dynamique du système bancaire comme élément opérationnel dans le cadre de la recherche d'une meilleure sécurité et stabilité de ce système ;
- la réflexion sur la mise en œuvre pratique de la surveillance réseau-centrique.
  - Des modules de programme ont été développés pour la modélisation et la simulation du comportement du système bancaire en tant que structure de réseau dans laquelle le choc financier est diffusé.
  - Une approche non-conventionnelle est appliquée pour évaluer et pour comparer l'efficacité des banques bulgares et des banques étrangères, basée sur la méthode DEA.

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## **Chapter I - OBJECTIVES AND PROBLEMS IN THE BANKING SPHERE, RELATING TO REGULATION AND SUPERVISION, IN THE PROCESS OF ESTABLISHING A SINGLE EUROPEAN FINANCIAL MARKET DURING THE CRISIS.**

### **1.1. Improving the regulatory framework and the supervision of the financial sector in the EU. Supervisory architectures**

The topicality of the issue of the structure of the supervisory processes always increases during crises, even more so as that is the time when most allocations of supervisory responsibilities at the institutional level are carried out. At the current stage, in contrast to previous financial crises, the discussion is of global nature. The coordination at the international level is raised as a priority, given that internationally active financial institutions (mainly banks) have a global reach through their subsidiaries and an international branch network.

This chapter presents an analysis of the national supervisory structures in EU Member States in recent years, as well as their institutional development. The emphasis has been placed on the most common types of supervisory architectures, taking into account their positive and negative sides. A number of factors determine their varied structure across countries. Experience shows that we almost never come across systems that are fully complying with a single theoretical model. The economic structure often does not play a significant role in the allocation of supervisory responsibilities; a decisive role is played by the established traditions, historical development, and sometimes purely non-economic factors. In recent years, however, the tendency is for a more intense involvement of Central banks in the supervision process at the micro- and macro-level, where this is accomplished mainly by returning the function of banking supervision on a consolidated basis to the Central bank, which is dictated by the importance of these institutions as regards the

systemic risk and the role of the Central bank in maintaining financial stability (Masciandaro et al., 2009; Masciandro & Quintyn, 2009).

The development of supervisory processes at the European level is directly related to the priority to establish the Single European Financial Market, raised in 1999. The financial crisis forced a reconsideration of the structure of financial supervision and regulation at the European level, by boosting initiatives for its improvement. The leaders of the G-20 agreed on the need to transform the financial institutions and in particular to increase the regulation of the financial system. That transformation opens up new opportunities for prevention based on early warning systems, and for ensuring the sustainability and viability of the financial institutions system.

The issues related to institutional development of supervisory architectures in EU Member States are determined by **the need for faster overcoming of the crisis in the financial sector.**

The current financial crisis has accelerated the activities to improve the financial supervision in the EU. In October 2008 the European Commission (EC) mandated a group of high-level experts, chaired by Jacques de Larosière<sup>1</sup>, to formulate recommendations for the future of European financial regulation and supervision.

The final report submitted by the de Larosière group on February 25, 2009, contains formulations to achieve greater efficiency in a new system of European financial supervision. Proposals have been laid out for new approaches to enhance cooperation and coordination between national supervisory authorities, including by establishing new European supervisory authorities, and for the first time – by

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<sup>1</sup> Jacques de Larosière is Chairman of the Strategic Committee of the French Treasury. He has held leadership positions, more important of which are: Managing Director in the International Monetary Fund (1978 - 1987); Governor of Banque de France (1987 -1993); President of the European Bank for Reconstruction and Development (1993 - in 1998). In 1992 he became a member of the influential Washington-based advisory body "Group of Thirty". Jacques de Larosière presented a report to the European Commission, which defends the establishment of a European Financial Stability Board to monitor the state of financial stability.

establishing an authority at the European level which will be given the task of overseeing the risks in the European financial system as a whole.

Based on the recommendations in the de Larosière Report, an action plan was prepared aiming to reform the regulatory and supervisory practices in the financial markets, as well as an accelerated timetable for its implementation. The discussions held in the European Council, the EU Council and the European Parliament demonstrated a broad consensus on the need for reforms and on the objectives to be achieved in accordance with the de Larosière Report and the European Commission's proposals for necessary future measures.

The development of a modern network approach for solving the basic problems related to the global crisis provides opportunities for security and stability in the financial system, by including the authorities for banking and financial supervision and regulation as major components. The aim is to achieve an effective organizational and functional transformation.

At the summit meeting in June 2012 the European Union agreed to create a new Centralized European banking supervision (as a step towards the establishment of a European Banking Union) to oversee banking reconstruction and recapitalization. This authority will provide direct assistance to banks, not governments, so that their debt does not increase further.

According to the governor of the French Central bank, Christian Noyer, all European banks, not just the most important, should be included in the supervision, in view of the experience from the Eurozone debt crisis.

The information material from the European Commission (EC, 2012) contains the statement that the European Commission also wants to create a new management framework, by entrusting national supervisors with additional powers to monitor more closely the banks and to take possible restrictive actions upon identification of risks.

In connection with the above we are carrying out a comparative analysis of national supervisory and regulatory architectures within the EU, and of opportunities for their institutional development in relation to problems solving upon the establishment of the Single European Market during crisis.

## **1.2. Types of supervisory architectures and their advantages and disadvantages**

The supervisory process includes micro-level activities on individual bank and non-bank financial institutions and the function of maintaining the financial stability at the macro-level. The micro-level supervision has two functions – supervision and regulation of the stability of individual financial institutions and the so-called supervision of the business practices of financial institutions. The process of supervision and regulation of the stability of financial institutions seeks to ensure the solvency and viability of individual financial institutions, which is achieved by stimulating rational behavior on the part of the executives of the financial institutions, primarily through supervising the capital adequacy, liquidity, maintenance of certain risk management systems, limitations on large exposures, etc. The supervision of business practices includes supervision of the transparency and disclosure of information by financial institutions, fair attitude towards their customers and consumer protection.

### **Types of supervisory architectures**

Several models of organization of supervisory structures can be identified on a global scale: vertical model (sectoral model), horizontal model ("twin peaks" model) and the unified model (a single supervisor).

The vertical model follows the boundaries of the financial system in the different economic sectors, and each sector is governed by a different institution.

The horizontal model is structured by taking into account the different orientations of the regulatory and supervisory process, where an individual institution is responsible for each orientation. A variant is the so-called "twin peaks" model in which the regular supervision of individual financial institutions (micro-level supervision) and the function of maintaining financial stability (macro-level supervision) is performed by one institution, and the supervision of business practices – by another.

In the case of the unified model, one institution integrates the supervision of all sectors of the financial market and all regulatory purposes. It should be noted, however, that in this case the regulatory activities are performed by separate institutions – the Central bank or the Ministry of Finance<sup>2</sup>.

Some of the key factors affecting the shaping of the supervisory architecture in a country are the structure of the financial markets, the weight of individual sectors, the degree of their integration and their significance in terms of system stability. In fact, few countries implement one of the models exclusively. In most cases it is a combination to varying degrees and in the respective proportions of characteristics of the above three models.

### **Main characteristics of the supervisory models**

The vertical model is most effective for **a financial market where individual sectors** (banking market, insurance market and securities market) **are relatively independent of each other**. The supervisory activity is carried out for the different sectors by the institution that has the power to do so for that particular sector.

The unified model applies mainly when **the banking, insurance and securities markets are fully integrated**. This model is based on a single institution that has a monopoly on the supervision of the entire financial market. Considering this, it is

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<sup>2</sup> Only in the Czech Republic and Slovakia the uniform supervisory authority performs a regulatory function, as the supervisory powers in these countries are consolidated in the central bank.

necessary to achieve conformity between the institutional supervisory structure and the market structure (Abrams & Taylor, 2000).

The Horizontal and the Unified model gained popularity with the increase of integration between the individual markets through the so-called financial conglomerates, but **the current global crisis suggested that the integration of supervisory authorities does not lead to increased efficiency, and in some countries<sup>3</sup> with such supervisory architectures a review of the current structures was launched.**

### **Supervisory architectures in practice**

The institutional structure of financial supervision is the subject of considerable attention, resulting from the attempt to draw lessons from the crisis. The analysis shows that most common worldwide are the vertical and the unified model (where the regulatory function and the supervision of business practices are performed by separate institutions), while the horizontal model has limited use.

Numerous studies name the financial conglomerates as an important reason for the integration of supervisory authorities. While part of the evidence supports this claim, there are exceptions: some financial systems with complex conglomerates are still applying the classic vertical model<sup>4</sup>.

In practice, most common are combinations of the said models, where in some countries certain institutions supervise several sectors of the financial market and in others – only one sector. In this context, the allocation of supervisory responsibilities often is determined mainly by the historical development of the respective financial

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<sup>3</sup> France, Germany, England and Belgium

<sup>4</sup> One example of sustainable supervisory structure is that of the U.S., where the existing model with a large number of supervisors practically has not changed in decades. Currently, the discussion there is not to change the model, but to reduce the supervisors. The U.S. government officials are well aware of the cost of a restructuring and its eventual failure. That is why we do not witness significant changes in the structure of this oversight, despite the large number of financial institutions and conglomerates.

market and the traditions and political relations, rather than by a definite economic model.

Studies indicate that, regardless of the different structures, the effectiveness of the supervisory activity is closely related to the independence of the supervisory institutions (Arnone et al., 2007; Masciandaro et al., 2008).

### **Supervision of financial groups**

One of the most cited reasons for the establishment of a unified supervision is the need for a unified supervision of financial conglomerates that operate in more than one sector of the financial market. With the expansion and ever growing complexity of the banks' activities the banks may include in their organizational structure financial companies that are related to other sectors of the financial market. With separate supervisors, the financial group could position certain financial services in that part of the conglomerate where the supervisory burden is minimized and the supervision is the most liberal. This in turn would lead to a restructuring of the financial institutions to avoid supervision costs.

In reality, in the case of the unified supervisory structures, the integration of the different areas often is superficial. The internal separation remains, thus preventing the increase of effectiveness of the supervisory process and creating opportunities for inconsistent policy of the institution as a whole.

### **Compatibility between the activities of financial institutions**

The practice of consolidation in recent years shows that the integration of supervisory structures does not contribute to the desired efficiency, since only banks and investment companies have overlapping activities, while the activities of insurance companies and pension funds are subject to disparate models (their risk lies on the liabilities side, unlike banks and investment companies). Besides, the control of the pension and insurance activity in many Member States is performed by an institution which is completely different from the micro- and macro-supervisors.

From a procedural perspective, the transformation itself and the synchronization into a new unified structure creates a period of inefficiency and a potential supervisory vacuum in certain sectors, which can lead to a decrease or loss of trust in supervisors and thus in the supervised institutions. This process is prolonged because of the necessary clarification of the rights and responsibilities of the new institution and its manner of interaction with the industry and other supervisory and regulatory authorities. Of importance for the future success of the new structure upon such transformations is the issue of maintaining the quality and the accumulated expertise of the personnel in the relevant supervisory authorities (Goodhart, 2000; Podpiera & Cihák, 2006). In the Netherlands, the process of restructuring the supervisors lasted for more than two years.

At the same time, a consolidation of the regulatory function, banking supervision and maintenance of financial stability within the Central bank occurs in smaller countries, as the predominant share of the assets of the financial system is held precisely by the bank institutions (European Central bank, 2006).

Furthermore, the need to strengthen international cooperation in this field should also be taken into account.

### **Insufficient flexibility and conservatism of the unified model**

It can be assumed that a single supervisor logically will have less flexible tools to solve supervisory problems. Its monopoly presents risks for biased treatment of market participants. Moreover, a single supervisory authority without responsibilities for supervision at the macro level would be more inclined to pursue a policy of excessive regulation and impede market innovations. In this case, the competition between the separate specialized supervisory institutions would be beneficial for the market development in terms of improved quality of supervisory policies and practices. **In developed economies (France, Germany, Italy, USA, etc.), irrespective of which supervisory architectures have been adopted, there never is just one institution to consolidate all regulatory and supervisory powers.**



The effectiveness of the integration of supervisory institutions into a single authority is threatened by the creation of a very large and complicated administrative apparatus, which would impede the smooth running of the supervisory process. Various studies have shown that **the integration of supervisory structures does not actually lead to savings in personnel and resources**. On the other hand, individual supervisory institutions with less bureaucracy have the advantage of greater flexibility and faster decision making.

### **Regulatory Activities**

Another **particularly strong disadvantage** which manifests itself **especially in the case of consolidated supervision outside the Central bank** is that such supervisory institutions lack the power to issue regulations. So they cannot fulfill their role as independent regulators, and this further reduces the dynamics of the supervisory process and the ability to react quickly according to the market situation.

## **1.3. Laying the foundations of modern regulatory and supervisory processes at EU level since the Lamfalussy report**

### **The establishment of a single financial market – a political priority**

Over the last decade, a priority at the European level was the establishment of a single financial market. The development of supervisory architectures was left to the decision of individual countries. This is the reason for the wide range of supervisory configurations.

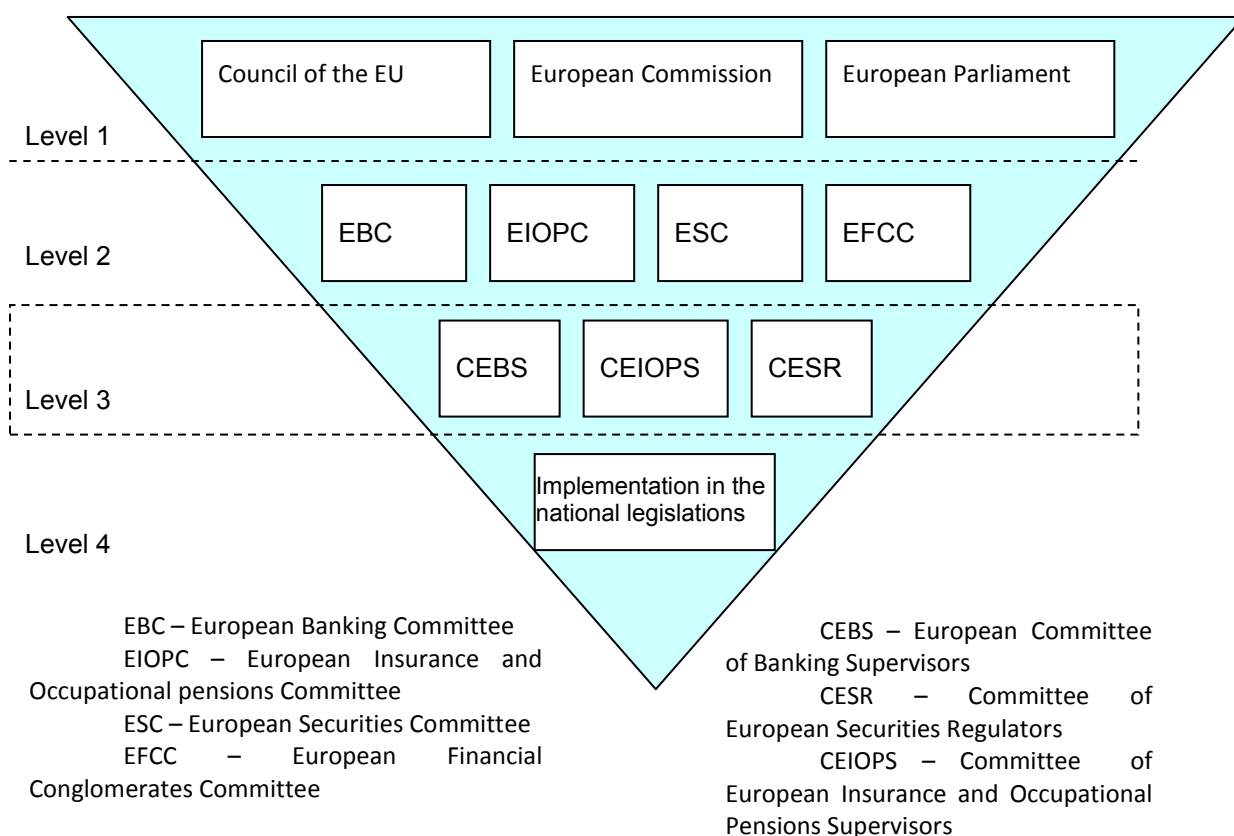
The main contribution to the harmonization of market structures was made by the guidance document drafted by the European Commission – Financial Services Action Plan (FSAP) adopted in 1999 – providing a framework for establishing a single financial market.

## The Lamfalussy structure

The ECOFIN Council (the economic and financial affairs council) decided in July 2000 to prioritize the establishment of a Single European Capital Market. The Wise Men Committee, chaired by Baron Alexandre Lamfalussy<sup>5</sup>, recommended a decision-making procedure relating mainly to the securities markets, which was adopted by the EU Council meeting in Lisbon. In 2002, the process of financial market regulation in the EU countries accelerated dramatically with the introduction of the developed Lamfalussy model. In December 2002 the ECOFIN Council developed an initiative for the expansion of the application range of the Lamfalussy process (model) from the field of securities to the field of banking and insurance. *Chart. 1.1* shows the structure of the model:

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<sup>5</sup> Baron Alexandre Lamfalussy is a prominent economist and banker. He has held leadership positions, more important of which are: founder and president of the European Monetary Institute in Frankfurt – forerunner of the European Central bank (1994 - 1997); chair of the Committee of Wise Men for regulation of the European securities market (2000 – 2001), whose recommendations were adopted by the EU Council in March 2001. As Chairman of the Committee, he led the creation of the "Lamfalussy" model for development of regulations in the field of financial services.



*Chart. 1.1*

### **The essence of the Lamfalussy model (process)**

The model consists of four levels; on the first (political) level the framework regulations of the EU are accepted in the form of directives and other regulations proposed by the European Commission after consultation with the interested parties. They are based on a principal framework and determine the powers of the European Commission, related to their implementation.

On the second level, after coordination with the Committees of the second level (the European Banking Committee, the European Insurance and Occupational Pensions Committee, the European Securities Committee and the European Financial Conglomerates Committee), the European Commission submitted to the third-level committees a request for technical opinions on the specific proposals for regulatory

measures (the Committee of European Banking Supervisors, the Committee of European Insurance and Occupational Pensions Supervisors, and the Committee of European Securities Regulators). These technical opinions are also based on consultations with market participants. The regulatory acts are subject to a vote in the European Banking Committee, European Securities Committee and the European Insurance and Occupational Pensions Committee, and a qualified majority is needed for their approval.

On the third level – the Committee of European Banking Supervisors, the Committee of European Insurance and Occupational Pensions Supervisors, and the Committee of European Securities Regulators assist the ongoing implementation of the adopted regulations into the national legislations. These bodies may issue guidelines and uniform standards (optional) to the national supervisory authorities and market participants, and make comparisons and reviews of national regulatory practices.

On the fourth level – the European Commission examines the compatibility of the legislation of Member States with the common European legislation.

## **1.4. Institutional development of the supervisory architectures in the EU Member States**

### **Historical perspective**

In recent years there have been significant changes in the structure of institutions responsible for supervision of the financial system. Given the predominantly strong influence of the banking markets in Europe in historical perspective, the development of financial markets over the past two decades leading to increased importance of insurance companies and investment and pension funds raised the issue of supervision of non-bank financial institutions and investor protection. As a result of these changes **the current supervisory architectures are increasingly more diverse**. In some countries there is the classic vertical model with

separate supervisory bodies for banking, insurance and securities markets (Spain, Italy, Greece). In some cases, a unified supervision outside the Central bank has been established (example: England, Germany, Hungary), while in other countries (Czech Republic, Ireland and Slovakia) the Central bank is the unified supervisory authority. Among EU countries only the Netherlands has adopted the horizontal "twin peaks" model.

A survey conducted by the European Central bank in 2003 highlights some similarities in the reforms of the national supervisory authorities: a stronger commitment of the Central banks to the supervisory process, even when they are not directly assigned such powers; an increased tendency for interaction between supervisors, contributing to financial stability.

At the European level, the period 2003-2006 was characterized by enhanced interaction between supervisors. In particular, the Lamfalussy structure was extended to cover not only the securities market, but also the banking and insurance sectors: the third level of the structure includes three sectoral committees with representatives of the national supervisory authorities, where the objective is to intensify the **supervisory and regulatory convergence in the EU**. These committees have an advisory role under the European Commission. It should be noted that **all Central banks participate in the third-level committee responsible for the banking sector (CEBS), whether or not they perform banking supervision function.**

According to the same survey by the ECB, the national supervisory architectures depend mainly on local peculiarities such as: historical development of the financial markets, established traditions, structure of the financial sector, structure of the national government, etc.

In recent years, thirteen countries have undertaken reforms, moving from the vertical (sectoral) model to one of the other two. However, the vertical model remains one of the most popular, existing in six countries: Greece, Spain, Cyprus, Lithuania, Slovenia and Romania. In other countries, the vertical model exists with

certain modifications: France (before 2010), Portugal, Finland (before 2009) and Luxembourg. As a variation of this model, in Finland and Luxembourg the supervision of banking and securities markets is integrated into a single institution. **Bulgaria may also be placed under the vertical model of allocation of supervisory responsibilities.**

The horizontal model, where the supervisory activities and the control of business practices are performed by different institutions (the "twin peaks" model), is fully recognized by the Netherlands<sup>6</sup>, while in other Member States (Italy) only certain supervisory responsibilities constitute an implementation of the principle of the horizontal model. Elements of such allocation are also present in the supervisory structures in France and Portugal.

**The general conclusion is that a clear trend towards a specific type of supervisory architecture could not be identified until recently. Every single choice was a result of historical factors, specifics of the financial and legal framework or other factors such as political opposition (Poland). As the financial crisis unfolded, a new trend emerged towards increase of the supervisory powers of the Central banks in terms of systemic risk and financial stability and in terms of banking supervision.**

### **The role of the Central banks before the de Larosière report**

**The 2003 analysis by the ECB (ECB, 2003) confirmed that the Central banks participate intensively in the regulatory and supervisory activities in EU countries.** In essence, since 2003 the number of countries where the Central bank has supervisory powers increased. The Czech Republic and Slovakia have transformed their Central banks into unified supervisory institutions. Some of the main reasons for this are independence, reliability and expert training of the personnel of the Central bank.

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<sup>6</sup> In the Netherlands, the supervision of financial institutions and the risk management is the responsibility of Central bank and the supervision of business practices is performed by a separate authority. In Ireland, for example, the function of supervision of business practices is integrated with Central bank.

In almost all Member States where the Central bank is not responsible for making financial decisions in the area of supervision, there are arrangements which secure its active participation in the supervisory process. In Germany and Austria, where the uniform supervisors are BaFin (the Federal Financial Supervisory Authority – Germany) and FMA (the Austrian Financial Market Authority), the Central banks are authorized by law to perform important supervisory tasks related to credit institutions. There is a wide range of institutional arrangements with different conditions, which include: sharing personnel (Belgium, France, Ireland, Latvia), sharing financial budgetary resources (Belgium, France, Latvia) or other resources such as IT infrastructure and databases (Belgium, Estonia, France, Ireland, Latvia, Finland, England). Three Central banks have been directly mandated to perform certain supervisory tasks (Ireland, Latvia, Hungary). In France, Estonia, Finland and Ireland the supervisory institution, although being an independent structure, is part of the Central bank in an organizational and administrative aspect.

In nine countries (Belgium, Estonia, France, Latvia, Austria, Poland, Finland, Sweden and England) the Central banks participate in the management of the banking supervisory activity, even though they do not have direct supervisory powers over banking institutions. This is accomplished through the participation of representatives of the Central banks in the governing bodies of the supervisory institutions. The representatives of Central banks are, by right, leading members of the banking supervisory authorities in Belgium, Estonia, England and Sweden.

The experience from the current crisis highlights the need to monitor the systemic risks arising from both the macroeconomic processes in the economy and the global financial markets. There is a growing consensus that the Central banks are in the best position to collect and analyze such information, given their activity in the conduct of monetary policy and serving as a lender of last resort, as well as their powerful statistical infrastructure.

*Table 1.1* shows the distribution of the 27 EU countries (*before July 2013*) according to the adopted supervisory architecture:

<b>Role of the Central bank's in the supervisory process</b>	<b>Unified model (single supervisor)</b>	<b>Horizontal Model ("twin peaks" model)</b>	<b>Vertical model (sectoral model)</b>	<b>Comment</b>
<b>CB has supervisory functions</b>	Czech Republic, Slovakia, Ireland (CBIC)	Netherlands France,	Bulgaria, Cyprus Spain, Greece, Italy, Lithuania, Romania, Slovenia, Portugal, Austria	Italy and Portugal have a "twin peaks" component
<b>CB have assigned supervisory functions or exercises them indirectly</b>	Belgium, Germany, Estonia, Finland, Hungary		Luxembourg	
<b>CB is not involved in the supervisory process</b>	Denmark, Malta, Latvia, Poland, Sweden, UK			UK has additional sectoral supervisor for pension funds, in addition to FSA.

## **The role of securities regulators**

There is a diametrical positioning of responsibilities relating to the functions of regulating the securities market. In ten Member States (France, Greece, Spain, Italy, Cyprus, Lithuania, the Netherlands, Portugal, Romania, Slovenia) there are separate institutions which supervise investment companies. In eleven cases (Belgium, Denmark, Germany, Estonia, Latvia, Hungary, Malta, Austria, Poland, Sweden, England) this function is part of the unified supervisory authority. In almost all countries the supervision of issuers and issues of securities (the supervision of business practices) is concentrated in a separate institution. In the Czech Republic, Ireland and Slovakia the supervision of investment companies is carried out by the



Central banks. In Bulgaria these powers are assigned to a mixed institution covering the non-bank part of the financial market, and Bulgaria is one of the few countries where the supervision of non-bank financial institutions and of business practices are entrusted to a single body. In Luxembourg the supervision of banking activities and investment companies is fused. In Finland, the uniform supervisory authority regulating the securities market is part of the organizational structure of the Central bank.

### **The supervisory architecture in Bulgaria**

Upon the establishment of the Financial Supervision Commission (FSC) in Bulgaria in 2003, a vertical model of separation of supervisory structures was adopted. This commission is a specialized government body for regulation and supervision of non-bank financial sectors, independent of the Executive branch and accountable only to the National Assembly. It succeeded the then existing State Securities Commission, State Social Security Supervision Agency and Insurance Supervision Agency, which were under the Government. The banking supervision is carried out by the Bulgarian National Bank. The purpose of such supervisory allocation is determined by the specific structure of the financial market, which is heavily dominated by the banking sector.

Although the supervision of bank and non-bank financial institutions is performed by different authorities, the coordination and dialogue between them is carried out through a number of channels, the highest level being the Financial Stability Advisory Council. This is an advisory body that helps to pursue a common policy for supervision of financial institutions. This council provides the exchange of information between participants and promotes security, stability and development of the financial markets in Bulgaria. The Financial Stability Advisory Council consists of representatives of the FSC and the BNB, and the Minister of Finance. At the invitation of the Council its meetings may be attended by the chairmen of the Budget and

Finance Committee and the Economic Policy Committee under the National Assembly, as well as by others.

It is characteristic for Bulgaria that the structure of the financial market is not integrated across its separate segments, but is influenced by the dominant presence of large European bank and financial groups. The total volume of bank assets is about 70 billion BGN, while the share of the other financial institutions is about 8 billion BGN.

**From the perspective of maintaining financial stability it is a priority that the Bulgarian supervisory architecture be synchronized vertically with the supervisory structures at the European level. At the present stage, the supervisory architecture in Bulgaria is consistent with the Lamfalussy model and with the new structure proposed in the de Larosière report, and a key factor for future development is the maximum facilitation of the interaction of Bulgarian supervisors with the new European structures – the European Systemic Risk Board (ESRB) and the three supervisors<sup>7</sup> in the European System of Financial Supervision (ESFS).**

## **1.5. Framework for financial regulation and supervision in the EU**

### *The financial crisis and the supervisory architectures*

The financial crisis has forced a reconsideration of the structure of financial supervision and regulation at the European level, by boosting initiatives for the improvement of the structure. The attempts to strengthen international coordination and interaction through the underlying principles of consolidated supervision, as well as through bilateral and multilateral memoranda of cooperation signed between supervisory authorities, proved ineffective. This led to the European Commission's proposal to build a new system of European financial supervision, with the task to coordinate and facilitate the activities of national supervisory and regulatory

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<sup>7</sup> European Banking Authority (EBA), European Insurance and Occupational Pensions Authority (EIOPA) and European Securities Authority (ESA)

authorities. On 27 May 2009 the European Commission published its proposal for the future structure of European financial supervision (based on the recommendations of the expert *de Larosière* group) (European Commission, 2009), which was adopted by the European Council on 18-19 June 2009.

The accepted framework introduced:

- **supervision at the macro-level (financial stability supervision) through the creation of the European Systemic Risk Board (ESRB)<sup>8</sup> under the European Central bank and**
- **supervision at the micro-level, performed by the European System of Financial Supervision (ESFS)<sup>9</sup> consisting of three independent European supervisory authorities: the European Banking Authority (EBA), the European Insurance and Occupational Pensions Authority (EIOPA) and a European Securities Authority (ESA).**

These three bodies supersede the previous committees on the third level of the Lamfalussy structure, which also follow the vertical model of allocation of supervisory responsibilities. The European Commission acknowledges that some Member States have different supervisory architectures, but states that **at the European level this vertical model is the most appropriate and provides continuity from the previous Lamfalussy structure. This continuity is shown in *Chart. 1.2*:**

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<sup>8</sup> ESRB – European Systemic Risk Board, chaired by the President of the European Central bank and including the governors of the 27 national central banks and the European Commission. It is envisaged that this structure will monitor the emergence of macro-level risks, and make recommendations for measures to be taken by the Member States.

<sup>9</sup> ESFS - European System of Financial Supervision – a decentralized structure consisting of three coordination bodies at European level – for banks, insurance companies and investment companies – with the participation of national supervisory authorities.

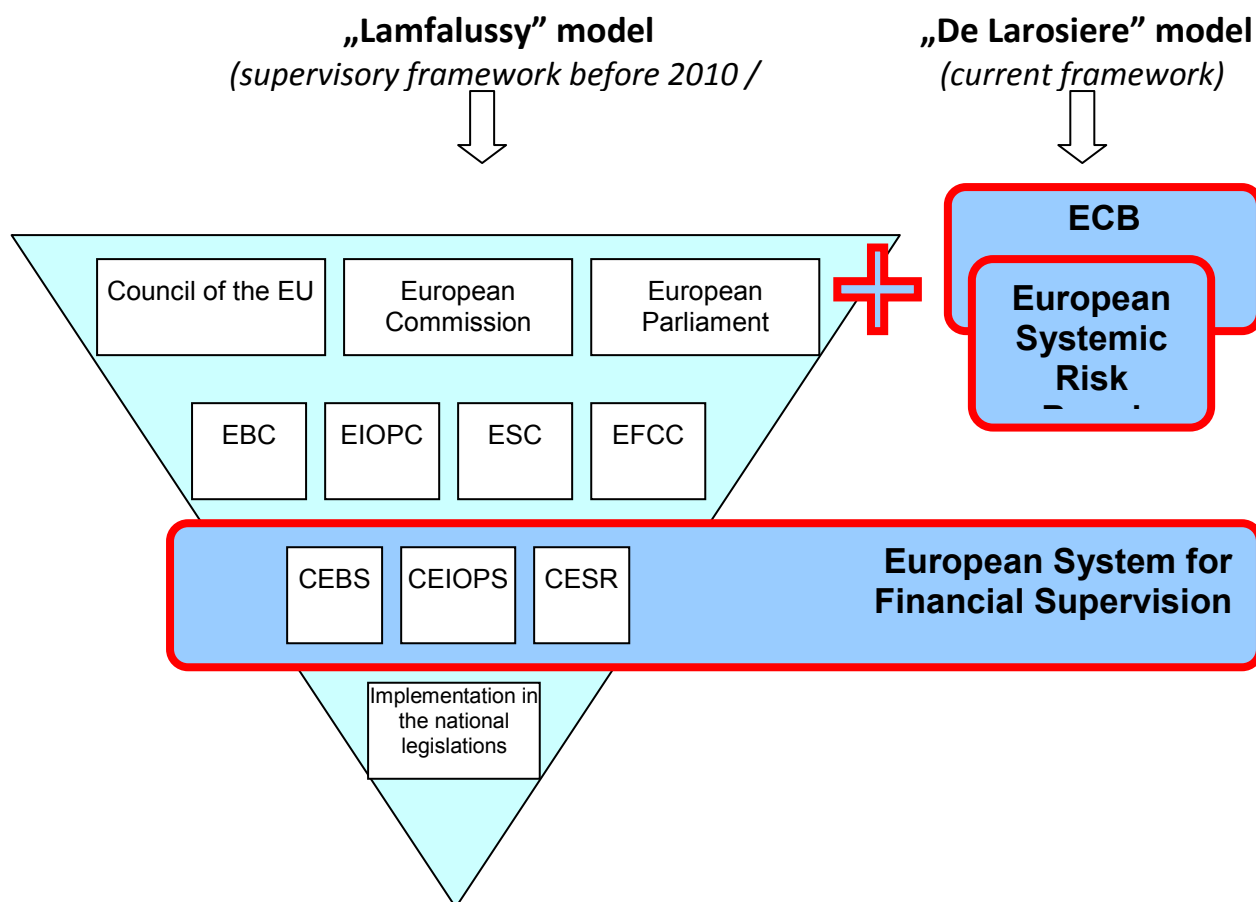


Chart. 1.2

## The European Systemic Risk Board

The responsibilities of the ESRB are related mainly to making decisions on regulatory policy at the macro-level, providing an early warning system in the EU, monitoring and analysis of macroeconomic events and generating suggestions for their management.

The role of the ESRB is to: collect and analyze all relevant information for monitoring and assessing potential threats to financial stability arising from the macro-economic situation and from changes within the financial system as a whole; identify and categorize such risks; issue risk warnings when the risks appear significant; issue recommendations on measures to be taken in response to identified risks where necessary; ensure that the necessary action is taken following the

warnings and recommendations; cooperate effectively with the IMF, the Financial Stability Board under G-20 and third countries.

The main task of the ESRB is to assess the stability of the financial system in the EU in the context of macroeconomic situation and the overall trends in the financial markets. When significant stability risks are identified, the ESRB will formulate early warnings and, where appropriate, make recommendations for remedial action. The issued warnings and recommendations may be of a general nature or concern individual Member States, and a time limit will be specified for taking the respective political action. These warnings and/or recommendations will be disseminated through the ECOFIN Council and/or the new European supervisory authorities. The ESRB will be also responsible for monitoring the compliance with its recommendations based on reports submitted by the addressees of the recommendations.

The European Systemic Risk Board will be at the centre of the new system, despite its having only advisory powers. **The predominant presence of representatives of Central banks is clearly manifested in the composition of the General Board of the ESRB, which comprises: the President and Vice President of the ECB, the governors of all twenty-seven Central banks in the EU, a representative of the European Commission, the chairmen of the new European supervisory authorities in the ESFS, representatives of national supervisory authorities and the President of the Economic and Financial Committee.**

The ESRB relies on the ECB for analytical and administrative capacity, and thus is controlled by it. The Ministers of Finance have only one representative in the ESRB, which shows the leading role of Central bankers in this institution.

## **European System of Financial Supervision**

**The European System of Financial Supervision** becomes an **operational European network** with shared and mutually reinforced responsibilities. At the EU level, the three existing Committees of Supervisors are replaced by three new

European supervisory authorities: the European Banking Authority (EBA), the European Insurance and Occupational Pensions Authority (EIOPA) and the European Securities Authority (ESA), each of them having a legal personality. These new European supervisory authorities assume all duties of the previous committees of national supervisors, and also have greater responsibilities, defined legal powers and greater authority. They also contribute to the development of a single set of harmonized rules and standards, improve the supervision of cross-border institutions by developing common supervisory requirements and approaches, and help settle any disputes between national supervisors.

The national supervisors continue to be responsible for the daily supervision of individual financial institutions. As regards cross-border institutions, the colleges of supervisors are the lynchpin of the supervisory system and play an important role in ensuring a balanced exchange of information between the authorities of the country of origin and those of the accepting country. The European supervisors will participate as observers in the meetings of the colleges of supervisors, thus contributing to the development of a common supervisory culture and consistent supervisory practices.

Set up in such a way, the ESFS combines the advantages of a common European framework for financial supervision with the expertise of local supervisors who have the best knowledge on the institutions operating in the different countries.

In order for the ESFS to perform its functions effectively, certain accompanying measures and changes in the sectoral legislation are necessary, to ensure a more harmonized set of financial rules. The aim is to achieve a higher degree of harmonization of the regulations to be applied by the supervisors, as well as greater coherence of the national powers and sanctions available to them.

According to the decision of the European Commission the three institutions within the ESFS should: be independent of political influence; have budgetary autonomy; report to the European institutions (European Commission, European

Parliament and Council of the EU); observe high standards of transparency of operations; support relations with the persons concerned – the users of financial services.

The purpose of these three bodies in broader terms is to: adopt and issue obligatory technical standards; carry out legally binding mediation; adopt legally regulating technical solutions as regards specific institutions; oversee and coordinate the supervisory colleges and interact with the ESRB to ensure adequate supervision at the macro level, as well as have an enhanced coordination role in times of crisis.

### **Changes in the structure of the European supervisory and regulatory process**

The European Systemic Risk Board enhances the role of the ECB in one other respect. Through this board, the ECB has access to supervisory information at the micro-level. During the financial crisis, ECB representatives criticized the lack of access to supervisory information on individual financial institutions. Such information is now provided through the database maintained by the three bodies of the ESFS, and the information it contains is available in a certain form also to the ESRC, after a confidentiality agreement.

Crisis management is mentioned as a task not of the ESRB, but of the ESFS. This is a step forward in the agreement that was reached at a meeting of the European Council in October 2008, according to which the President of the European Central bank (in accord with the other European Central banks) and the heads of the European Commission and the EU Council become part of a unified European structure for crisis management.

Compared to the committees of the third level of the Lamfalussy structure, the new authorities in the EFSF experience a considerably larger workflow. Having in mind that the third-level committees play a primarily advisory role in the regulatory issues, the new authorities have, in addition to that, many supervisory functions as well. The working out of a Single rulebook and the ensuring of consistent

implementation of EU regulations continue and expand the regulatory tasks of the new structures. Besides the control functions, the establishment of a central database of supervisory information constitutes an additional and onerous task. This includes: coordination of the supervisory analyses of the financial groups; ensuring consistency in supervisory results in the financial groups, participation in supervisory colleges, supervision of pan-European institutions, developing a uniform training program for supervisors.

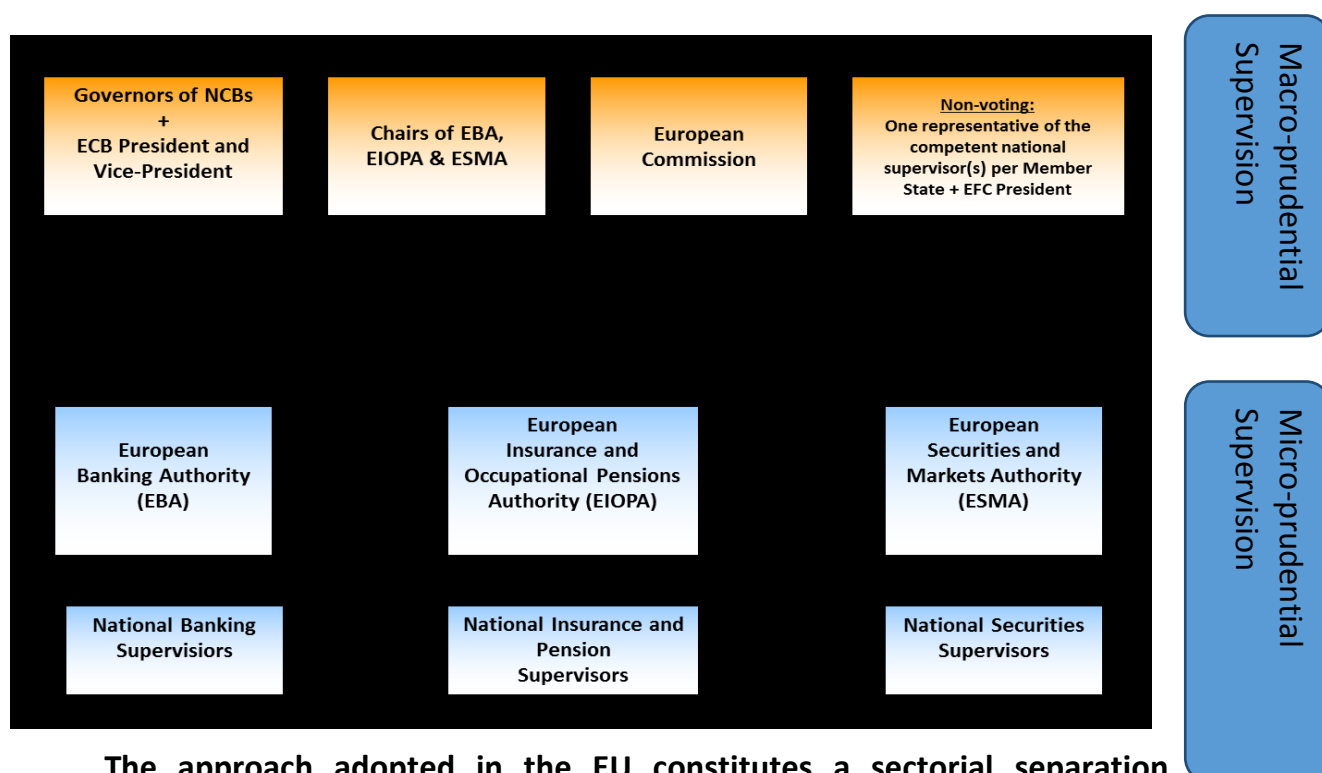
The Lisbon Treaty facilitates the implementation of the new framework and in particular of the Single rulebook and the harmonized supervisory practices. The Lisbon Treaty clarifies the hierarchy of legal norms within the EU regulatory framework and makes the distinction between legislative acts, delegated acts and implementing acts. They replace the previous "comitology" that the Lamfalussy structure was for the financial markets. The delegated act empowers the Commission to adopt regulations of general application to supplement or amend certain non-essential elements of the legislative acts. An implementing act is adopted when a uniform application of certain legally binding EU acts is necessary. The implementing act can assign implementing powers to the Commission. This makes it possible for the decisions of the former committees on the third level of the Lamfalussy structure to become obligatory.

The ESFS bodies retain a relative independence. In its conclusions, the EU Council (Council, 2009) reiterates that they must be independent of national authorities and the European institutions. They assist the Commission with the consistent interpretation and application of the Community law. The decisions they take should not affect the fiscal responsibilities of Member States, which somewhat limits their powers. Another problem in this regard is the supervision of pan-European institutions. The latest regulations for credit rating agencies entitle the Committee of European Securities Regulators (CESR) to register a credit rating agency in accordance with the new rules and to make decisions on applications for registration and to notify the relevant authorities in the Member States. The central



counterparties and settlement institutions are another area of responsibility. The conclusions of the ECOFIN Council also noted that some Member States disagreed with this approach, as it could affect national fiscal responsibilities. The same rationale applies to crisis management, where the ESFS authorities have only limited responsibility to make emergency regulatory decisions.

Chart. 1.3 presents the scheme of interaction between the separate institutions:



The approach adopted in the EU constitutes a sectorial separation supervisory institutions (vertical model), which confirms the traditional vertical model. The three-tier framework for supervision at the micro-level (ESFS) is made at the lowest level of a large group of national supervisory architectures differing in structure (47 institutions in 27 countries (*before July 2013*)) with various rules of management, supervisory cultures and regulatory frameworks.

By including in that framework the ESRB, which will perform analysis for maintaining the financial stability, we see that at a higher level the structure resembles the so-called "twin peaks" model, where the supervision at the micro- and macro-level is split into separate institutions.

The financial crisis has shown that the supervision of individual institutions (supervision at micro-level) is not enough. This possibility must be supplemented by a supervision at the macro-level so as to identify imbalances in the development of the financial system (Goodhart & Schoenmaker, 2009). Furthermore, the macro-level supervision is needed to counteract the pro-cyclical nature of capital adequacy rules. This task is entrusted to the European Central bank.

The approach adopted provides a decentralized supervisory process that is close to the financial institutions and markets, while the new European supervisory authorities ensure a common approach and resolve any disputes between national supervisory authorities in respect of certain financial groups. Over time it is possible that these European authorities will begin to implement direct supervision of large cross-border banks. Thus the supervisory process will be closer to the existing structure of the European financial market, where 70 percent of the banking assets are controlled by 43 banks with significant international presence.

The financial crisis has shown that the current structure of the national supervisory authorities cannot deal effectively with cross-border financial institutions. An example of this is the bank Fortis, whose rescue was carried out at the national level, where the Netherlands took care of the Dutch part (acquired by ABN Amro), and Belgium and Luxembourg took responsibility for the remaining part of the bank.

## **Approaches to regulation and supervision of the financial sector in the EU**

**The framework for banking supervision at the European level developed by the European Commission applies approaches relating to the formation of decentralized network architecture** and an early warning system at the highest level. There is a growing consensus in the economic literature for recognition of the significant impact of network structures on many social and economic activities. The network approach to financial systems is essential for the assessment of financial

stability. For example, the resilience of the banking system to shocks can be evaluated according to the network structure that connects the financial institutions.

The modern networking concepts are created in relation to the possibility of applying the advantages of information technology primarily in security systems. The development of a network structure of an **early warning system** at the highest level, its combining with the networks of the European regulatory structures and specific supervisory authorities at the respective levels, and their linking to the networks of banks and other non-bank institutions allows for the implementation of the network system. This is practically a system of systems (a network of networks) whose characteristics (or properties) are the synergetic effect of the respective characteristics (or properties) of their constituents. This furthermore creates an opportunity to achieve new states of the integrated (European or global) financial system in which the system as a whole acquires qualitatively new properties, impossible to be achieved by its individual parts alone. This ensures the viability, stability and efficiency of the operation.

The need to adopt a network approach and an early warning system is outlined in the de Larosière report in several paragraphs and recommendations. In this respect **the new regulatory system established by the European Commission is essentially a decentralized system of systems involved in the supervisory and regulatory processes.** The individual national supervisory authorities interact on a decentralized basis within colleges of supervisors or on the grounds of signed memoranda of cooperation. At the same time, the three supervisory authorities at the European level which form the ESFS coordinate and facilitate the work of national supervisors, while helping to synchronize the financial regulations and supervisory practices underlying the integration of financial markets. From another perspective the ESRC and the ESFS interact between themselves and with the ECB and the European institutions, responding to potential threats to the stability of the banking market, thus forming a system of a higher level. This system is essentially a system of

systems. The advantage of such network structures with decentralized management is that they are more resistant to crisis situations and to violations of their integrity.

## 1.6. Development of the financial supervision and regulation in the EU Member States in the light of the global financial crisis

### Development of financial architecture in recent years

In relation to the impact that the introduction of the Euro had on the supervisory structures, many central banks that did not supervise individual banks (supervision at micro-level), but performed the function of maintaining financial stability (supervision at macro-level), lost positions since the ECB took over the monetary policy, depriving them of the last mechanism of influencing the financial system and of one of the main sources of information. In order to strengthen the capacity to preserve the financial stability a number of countries took **measures to return the banking supervision within the structure of the central bank**. In other cases, the functions of supervision of the entire financial system were included and integrated in the central bank (the Czech Republic, Slovakia, Ireland, the Netherlands). In Germany, the supervisory activity is undertaken by the unified supervisory authority BaFin, which is an independent body, but the regulatory and monitoring activities are carried out by the central bank. The debates treat the return of the old regime, in which the German central bank supervised banks on a consolidated basis. The structure of the German banking groups is characterized by their high degree of integration with insurance companies. So in essence the German central bank will supervise these within the consolidated supervision framework. The changes are confirmed by the agreement between the coalition partners announced on October 24, 2009, which contains the plan to make the German central bank exclusively responsible for banking supervision.

The current financial situation leads to a reassessment of the changes made before the crisis. In recent years there has been **a tendency to strengthen the**

**relationship between the Central bank and other supervisory bodies, as well as to entrust the Central banks with new responsibilities in the fields of systemic risk and financial stability. All these changes are made in accordance and interaction with the supervisory structure at the European level, as set forth in the de Larosière Report.**

In Austria in 2008 and in England after the rescue of Northern Rock, **debates were initiated on the strengthening of the role of the central bank in the supervision of banking groups, considering their significance for systemic risk.** These debates emerged due to the current situation where the Bank of England, although it is responsible for maintaining financial stability, virtually lacked information about specific banks and instruments for influencing, and this impedes the realization of supervision at the macro-level. In 2008, a reform was undertaken in Austria, according to which all functions of remote supervision of banks and on-site inspections were assigned to the Austrian central bank, which had hitherto been responsible for maintaining financial stability. Up till then the supervision at the micro-level had been performed by the Financial Market Authority (FMA). So, after the changes, the competences of the FMA as regards the banking market consist only of the power to impose supervisory measures.

Germany, Belgium and France also began to reconsider the role and place of supervisory powers over credit and financial institutions. It was an opportunity for the initiation of such discussions in other countries that remained outside the previous round of reforms. The clearest example of this is the U.S., where the proposed measures are not aimed at changing the model, but at reducing the large number of supervisory institutions.

In connection with the changes in the European supervisory framework, Banque de France announced in July 2009 the intentions of the French government to integrate micro-and macro-supervision of banking and insurance institutions in France into the structure of the central bank, and leave outside its scope the

regulation of the business practices of these same institutions and the supervision of securities markets and investment companies. The new regulatory body Autorité de contrôle prudentiel (ACP) is under the control of the French central bank and is the result of the merger of Commission bancaire, Autorité de contrôle des assurances et des mutuelles (Acam), Comité des entreprises d'assurance (CEA) and the Comité des établissements de crédit et des entreprises d'investissement (CECEI). The creators of the project hope that ACP, existing under the control of the central bank, will ensure stability throughout the French financial sector. Another objective of the reform is to strengthen the supervision of the financial products market. It was decided to introduce structured cooperation between the ACP and the supervisory authority for the financial markets, AMF. The new regulatory body Autorité de contrôle prudentiel (ACP) operates from the beginning of 2010. Similar processes occur in Belgium and Germany. The strengthening of the role of the central bank in the micro- and macro-supervision of the banking and insurance institutions is also discussed in Great Britain.

In October 2009 the governors of the Belgian central bank and of the Single supervisor (CBFA) announced their mutual intention to bring closer the activities of supervision at the micro- and macro-level. It was decided to establish a Committee of systemic risk, and to subsequently seek ways to integrate the activities of the two institutions. The ultimate goal is for the Belgian central bank to exercise overall supervision at the micro-level, while the new CBFA will be responsible for the financial markets (supervision of business practices). In this way the "twin-peaks" model will be realized.

The political authorities in Italy and Spain have recently expressed their intention to reorganize their supervisory architectures. In 2005, the Spanish Parliament discussed the introduction of a hybrid model by which to reform the institutions charged with antitrust responsibilities and the involvement of the central bank in the supervisory process. In Italy, the government announced its intention to

separate the function of financial stability and supervision of business practices, thus realizing a horizontal model for allocation of supervisory responsibilities.

In some countries, the banking supervision function is already integrated into the central bank (Austria) and in others the oversight of the entire financial market is integrated into the central bank (Ireland, Czech Republic, Slovakia, the Netherlands, Finland).

Ireland is in the process of implementing changes to the organizational structure of the central bank and Financial Services Authority of Ireland (CBFSAI). The key point is the establishment of a new Irish central bank to supervise financial institutions with the aim to ensure the financial stability of each of them and of the system as a whole. In June 2009, the Minister of Finance in Ireland announced the government agreement for the establishment of a single fully integrated regulatory institution called the central bank of Ireland Commission. The new organization replaces the former structure central bank and the Financial Services Regulatory Authority. The new central bank Commission is chaired by the Governor of the Irish central bank and is responsible both for the supervision of individual financial institutions and for the maintenance of financial stability. The function of consumer protection is set apart into a separate agency (National Consumer Agency), which also assumes the antitrust function.

In the Netherlands, a distinction is made between the supervisory activities for which the central bank is responsible, on the one hand, and the supervision of business conduct, for which the Netherlands Authority for the Financial Markets (AFM) is responsible, on the other hand.

The Finnish central bank established in January 2009 a new supervisory institution under its governance. It resulted from the merger of the Financial Supervision Authority (FSA) and the Insurance Supervision Authority (ISA), which was previously under the Ministry of Social Affairs.

If it is at all possible to make some assessment of the potential impact of different national supervisory models on the manifestation of the current financial crisis, it is logical to look at the example of the Member States in the Eurozone (who are also countries with mature, highly integrated and complex financial systems). In this regard, it can be concluded that despite the lack of direct evidence for a specific supervisory model being perfect, the most affected banking systems in Europe are those in the UK, Germany, Belgium – the Member States where there is a clear separation between micro- and macro-supervisory functions, i.e. where the micro-supervision of individual credit / financial institutions is outside the central bank, which in turn is responsible for maintaining the financial stability at the financial system level.

### **Guidelines for the development of national supervisory architectures - interoperability**

The network of national supervisors is characterized by two dimensions – their architecture and their management rules. Although **there is no such concept as best practices in the area of supervisory architectures**, it is obvious that the issue of coordination between the supervisors can come to the fore, given their great diversity, and especially considering the different management rules pertaining to the different architectures.

In this regard, we can conclude that there is **a change in focus from the national to the European level** and a search for ways to achieve greater interoperability between national architectures and the European Supervisory Authorities. In this context, the evolution of the supervisory architectures should follow the integration of markets, especially in the financial sector, the focus being for the supervisors to become ever more global.



## **1.7. EC proposal for the creation of a mechanism for the Eurozone banking supervision**

On 09.12.2012, the European Commission published a legislative proposal for a Council decision entrusting the European Central bank with specific tasks concerning policies relating to the prudential supervision of credit institutions, the draft amendment to the existing regulation for the European Banking Authority and communication.

In the EU there will be a single mechanism for banking supervision, officials said. The decision was taken in Brussels, finance ministers of the EU countries. One supervisory mechanism will be introduced by March 2014 rather than late 2013 as planned earlier. Final approval of the resolution will be voted at the meeting of the Heads of the EU.

### **1.7.1. Nature of the proposal**

The explanatory memorandum to the proposal (EC, 2012) noted that in order to restore confidence in banks and the euro to create a bank union that is part of a long-term vision for economic and fiscal integration. One of the key elements of the of the banking union should be a Single Supervisory Mechanism (SSM) with direct oversight of banks, to enforce prudential rules in a strict and impartial manner and perform effective oversight of cross border banking markets. If such a mechanism be created for Eurozone banks, including the ECB, the European Stability Mechanism (ESM) would after a regular solution to be able to recapitalize banks directly. Ensuring that banking supervision across the Euro area abides by high common standards will contribute to build the necessary trust between Member States, which is a pre-condition for the introduction of any common backstops.

It is noted also that the proposal - the ECB is assigned certain important supervisory tasks related to supervision of credit institutions, all tasks that are not

defined in the regulation will be the responsibility of national supervisors. The proposal confers certain key supervisory tasks necessary for the supervision of credit institutions on the ECB, while all tasks not spelt out in the regulation will remain the competence of national supervisors. The proposal also provides for the ECB to supervise financial conglomerates, the ECB will be responsible only for performing the tasks on the supplementary supervision of financial conglomerates at group level, while prudential supervision of individual insurance companies will be conducted by competent national authorities. The project provides for the ECB to play a central supervisory responsibilities associated with granting and withdrawal of licenses of credit institutions, evaluation and authorization for the acquisition of an equity interest in a credit institution the right to request and collect information, the right to conduct inspections for compliance with regulatory requirements including checks "in place", the right to impose individual capital measures relating to the risks and measures for the implementation of early intervention and the right to supervise financial conglomerates Specific supervisory tasks of the ECB and to impose sanctions.

### **1.7.2. Specific supervisory tasks of the ECB**

As indicated in the detailed description of the proposal after a transition period the ECB is responsible for implementation of key supervisory tasks to all credit institutions established in the participating Member States, regardless of their business model or size. The ECB will be receiving supervisor for credit institutions established in the participating Member States, when they open a branch or provide cross-border services in a participating Member State. ECB will carry out its tasks within the European System of Financial Supervisors and will collaborate closely with the three European Supervisory Authorities. EBA will retain its powers and duties in connection with the further development of uniform regulations and ensuring consistency and convergence of supervisory practices.

ECB (EC, 2012) will have exclusive jurisdiction in respect of important supervisory tasks whose execution is necessary to identify the risks to the economic

viability of banks and require them to take appropriate action. ECB, inter alia, will be the competent authority for the licensing of credit institutions, assessment of the qualifying holding, to ensure compliance with the minimum capital requirements to ensure the adequacy of internal capital depending on the risk profile of the credit institution (Pillar 2 measures ) to exercise supervision on a consolidated basis and execution of supervisory tasks in relation to financial conglomerates. In addition, it will ensure compliance with regulations on leverage and liquidity, capital buffers will apply and shall, in coordination with the resolution authorities, early intervention measures when a bank has breached, or is about to violate regulatory capital requirements. For questions related to the above tasks, the ECB will coordinate and express the common position of the representatives in the Board of Supervisors and the EBA Board of the competent authorities of the Member States participating.

It is envisaged that the ECB is a special Board of Supervisors (Supervisory Board), which will operate independently of the Governing Council and the key decisions relating to the supervision of credit institutions. It is recommended that the following members: four representatives of the ECB, plus one representative from each member state of the euro zone. The ECB has been proposed to coordinate the presentation of common positions in the governing bodies of the European Banking Authority on behalf of the member states of the Eurozone, and decisions by the Board of Supervisors to specify an additional internal rules. Available supervisory activities of the ECB to be co-financed through the charging of credit institutions, which will cover the costs incurred.

### **1.7.3. The role of national supervisors**

Under the proposal (EC, 2012) after the establishment of a single supervisory mechanism national supervisors would continue to perform all the tasks not conferred on the ECB. For example, national supervisors will remain in charge of consumer protection and the fight against money laundering, and of the supervision of third country credit institutions establishing branches or providing cross-border

services within a Member State. National supervisors will continue to play an important role with the creation of a Single Supervisory Mechanism.

Also in connection with the tasks assigned to the ECB, most of the daily inspections and other oversight activities necessary for the preparation and execution of the acts of the ECB could be implemented by national supervisory authorities, acting as part of a supervisory mechanism. SSM covering all banks participating Member States, can work only on the basis of a model that combines great expertise at the national level. The proposal was reported that national supervisory authorities within the ENM in many cases are better prepared to engage in such activities because they are familiar with national, regional and local banking markets with local characteristics, have significant resources and master language and thus the ECB can largely rely on national authorities. Moreover, national authorities will retain some of its operational functions related to the verification of the received information and operational status monitoring of credit institutions and the preparation of proposals to the ECB for approval of internal models for risk assessment.

From here these basic activities in a fixed proposal (EC, 2012), shows the objective necessity of accelerating the operation of supervisory processes and the realization of highly efficient single supervisory mechanism.

#### **1.7.4. Opportunities for Bulgaria's participation in a supervisory mechanism**

Bulgaria supports the idea of creating a single European banking supervision mechanism, said (Djankov, 2012) Deputy Prime Minister and Finance Minister Simeon Djankov. "This is a big step in and correct the single financial market and the development of the single market Only the Eurozone." He stressed, however, that the realization of the idea still needs to be cleaned much controversy. To enter into force, the Commission's proposal must be approved by all 27 member states (*before July 2013*), and 17 countries of the Eurozone will be required, and the remaining 10

countries, among which Bulgaria will be able to choose whether to join. Among the EU countries is still no consensus on the issue, despite the obvious interest of the member states for progress. In the words of Minister Djankov evidenced held during the two-day informal meeting (September 2012) of finance ministers and central bank governors of the EU in Cyprus - a total of 4 formal and informal meetings on this topic.

A serious contradiction cited by the BNB Governor Ivan Iskrov while held on June 27, 2012 Round Table on "The stability of the banking system - a prerequisite for sustainable economic growth," is that non-euro countries have no access to financial assistance for banks. The idea is that a single monitoring and increasing the powers of the ECB will allow it to directly inject funds permanent Eurozone bailout fund (the European stabilization mechanism, ESM) in need of help banks, but which banks outside the monetary union no access . In the words of Minister Djankov But for the most part the banking system in Bulgaria anyway fall under the general supervision because three quarters of the financial institutions are part of a major European financial groups that will be included in a single device. According to the Finance Minister, "the introduction of the single banking supervision will not be a problem for banks in Bulgaria" and the country is in a relatively good position, especially given the fact that the Bank has a very positive experience in the past 15 years in dealing with crisis situations.

The EC proposal includes a mechanism Member States outside the euro area to cooperate closely (close cooperation) with the supervisory activities of the ECB, adopt unilateral application and enforcement of supervisory measures adopted by the ECB. For Bulgaria, this possibility does not seem reasonable at this stage as it will bind unilateral activity of the supervisory authority in the decisions of the ECB, without thereby ensuring sufficient interests of depositors and taxpayers, through access to ECB refinancing operations and the total mechanism for capital support through the European Stability Mechanism (ESM). Envisaged in the project attended by a representative of the national supervisory authority of the Member State which

entered the mechanism of cooperation with the ECB, the Board of Supervisors of the ECB does not guarantee sufficient protection of the national interest in making collective decisions of this body. Countries outside the Eurozone, that will join the mechanism under the regime of close cooperation, transfer key supervisory powers to the ECB but will not have access to the ECB liquidity facility and to ESM.

#### 1.7.6. Changes in regulation for the European Banking Authority

EC initiative includes a proposal for changes in the regulation of the activities of EBA. In this proposal noted that the creation of the European Banking Authority and the European System of Financial Supervisors e help to improve the cooperation between national supervisors and the development of a single regulatory framework for financial services in the EU. However, **since the banking crisis up to now there are failures in oversight that led to a significant decline in confidence in the EU banking sector and contributed to increasing tensions in the markets for sovereign debt in the Eurozone.**

The proposal involves only modification of procedures by which act EBA, to reflect the assignment of supervisory tasks of the ECB and to ensure that the EBA can continue to fulfill its obligations to protect the integrity, efficiency and orderly functioning of the internal market for financial services and to maintain the stability of the financial system within the domestic market. It does not change the balance of powers between the relevant national authorities and the EBA. The provisions in the proposal do not go beyond what is strictly necessary to achieve the objectives pursued. The proposal therefore complies with the principles of subsidiarity and proportionality set out in Article 5 of the Treaty on European Union. The most important changes are associated with the required voting majority decision by the Board of Supervisors. Qualified majority required for a decision by the Board of Supervisors for approval EBA technical standards, guidelines and oversight is maintained.

## 1.8. General conclusions for the improvement of the regulation and supervision of financial markets

The following conclusions may be drawn from the survey and analysis carried out:

The allocation of supervisory responsibilities is determined mainly by the structure of the financial market, the weight of individual sectors, their degree of integration and their significance in terms of system stability.

The integration of supervisions does not necessarily lead to increased effectiveness of the supervisory process. Indeed, in the case of the unified supervisory structures, the integration of different areas often is superficial. The internal separation remains, and this hampers the increase of efficiency and creates possibilities for inconsistent policy on the part of the institution as a whole.

In developed economies, regardless of the adopted supervisory architectures, there is no single authority which consolidates all regulatory and supervisory powers.

**In the smaller EU countries we see a consolidation of the regulatory function, banking supervision and maintenance of financial stability within the central bank, as the bank institutions have a major share of the assets in the financial market.**

**As the financial crisis unfolds there seems to be a new trend towards strengthening the supervisory powers of the central bank in terms of systemic risk and financial stability and in terms of banking supervision.**

The unsuccessful attempts to strengthen the international coordination and cooperation through voluntary mechanisms require the establishment of **a new system of European financial supervision** to coordinate and facilitate the activities of national supervisory and regulatory authorities.

**With the integration of the financial markets, the focus changes from the national to the European level and the evolution of the supervisory architectures**

should follow this integration. The aim is to achieve greater interoperability between national architectures and the European Supervisory Authorities.

### **Implications for Bulgaria**

The current structure of supervisory institutions in Bulgaria meets the modern requirements for effective financial supervision. The allocation of supervisory responsibilities between the BNB and the FSC has a strong justification related to the structure of the Bulgarian financial market where banks have a leading role with a share of over 90% of the assets in the financial market. An additional positive characteristic is that both institutions have the right to issue regulations, which ensures the efficiency of the regulatory process.

The structure of the Bulgarian financial market is not integrated across its segments, and is influenced by the dominant presence of large European bank and financial groups. From the perspective of maintaining financial stability it is a priority that Bulgarian supervisory architecture be synchronized vertically with the supervisory structures at the European level.

The Bulgarian supervisory system gains additional stability through its compatibility with the Lamfalussy model and with the new de Larosière structure. This fact is crucial for the effective interaction of the BNB and the FSC with the European Systemic Risk Board (ESRB) and the three supervisors in the European System of Financial Supervision (ESFS), especially in crisis situations.

The main conclusion of the study is that regulation and supervision are key for achieving the necessary transformation of the banking system in the European Union.



## **Chapter II - NETWORK APPROACH FOR ANALYZING THE FINANCIAL SYSTEM AND BANKING INSTITUTIONS**

The application of the network approach to the financial system may be the key for finding solutions to the global crisis. There is a growing consensus in the economic literature for recognition of the impact of network structures on many social and financial activities. Using the theory of networks, one can improve the functioning of the financial systems. The application of Network approach to the financial systems is especially important in assessing financial stability. For example, the resilience of a banking system to shocks can be evaluated according to the network structure that connects the financial institutions. The European regulatory bodies – the European Systemic Risk Board and the European System of Financial Supervisors are network elements at the EU level. The inclusion of these structures and the banking system in a single framework will form a complex multilevel system, called network of networks, where its characteristics are the synergetic result of the relevant characteristics of their constituents, so it acquires qualitatively new properties impossible to be achieved by its individual parts alone – it achieves greater viability and operational efficiency.

The aim is to achieve effective organizational and operational transformation in order to ensure sustainability and viability of the system of financial institutions in case of failure of some of its units.

We already know that the banking system is a highly interconnected and complex structure. To reveal its behavior, it is most appropriate to apply a network model. We are applying a contagion model simulation, which shows us the reactions of the system when a shock is introduced – its resilience and fragility. We find that depending on the level of network integrity and the structure of the individual banks, a shock could be absorbed or could lead to near collapse of the whole system.

## 2.1 Network simulation approach

For a better analysis of the financial stability of a system we should first take a look at its structure. The financial markets are largely integrated complex network structures. In the next chapter we will call them “economic infrastructure”. So it is most appropriate to use a network approach when describing the banking market. This market is composed of a number of banks connected by interbank linkages (debt or equity exposures).

For safeguarding and maintaining the stability of this economic infrastructure, first we have to find the answer to the question: what is the behavior of the banking system in a crisis situation? There are many factors affecting the banking system’s behavior but we will focus on one of the main sources for systemic risk – the interbank connections.

There are significant network analyses applied to credit networks (Gatti et al., 2010; Krznar, 2009; Toivanen, 2009). In this regard, the theory of financial contagion has been noted, originally proposed by Allen & Gale (2001) about the network model of the interbank market. Further studies on this market include (Freixas et al., 2000; Furfine, 2003; Boss et al., 2004; Iori et al., 2006; Nier et al., 2008) and on the corporate sector: (Boissay, 2006; Battiston et al, 2007).

As highlighted in (Nier et al., 2008) the systemic risk has focused the attention of the central banks, which are required to protect the overall financial stability.

A significant research on systemic bank default has been done by Demirguc-Kunt & Detragiache (2002) and Barth, Caprio & Levine (2006), but relatively little research has been done on how the structure of the banking system can influence susceptibility to systemic default.

While exploring this area, Nier, Yorulmazer & Alentorn (2008) focused their attention on the role of direct interbank connections as a source of systemic risk and explore potential chain defaults caused by these exposures. The study (Nier et al., 2008) also notes the fact that many authors like Sheldon & Maurer (1998), Furfine

(1999), Upper & Worms (2004), Wells (2002), Boss, Elsinger, Summer & Thurner (2004) examine the financial stability on the basis of empirical studies on the importance of interbank connections. However, these studies fail to take account of key parameters such as the capital of the institutions, the size of interbank exposures and the connectivity and concentration in terms of the stability of the banking system.

Barre et Al. (2012) focus their attention on the analysis of the destabilizing role of interbank network relations through the perspective of the effect of the risk management practices like securitization.

Following Eholi (2004), Nier, Yorulmazer and Alentorn consider the banking system as a network of cores, where each core is a bank and each link is a lending relationship between two cores. The banking system needs to meet certain constraints on the balance sheet indicators, at both the bank and the system levels.

Following the architectural and structural approach taken in the thesis, we apply the above methodology of Nier, Yorulmazer and Alentorn and unfold the application of the simulation model describing the network of banks related through debt exposures. Initially, to facilitate the model at this stage, we assume the existence of a homogeneous banking system, i.e. the banks are randomly connected to each other and each bank has an equal chance to be connected to any other bank.

## 2.2 Modeling the banking system

We are constructing a random graph with predefined number of nodes (banks)  $N$ , which have lent to one another with probability of  $p$ . So  $p_{ij}$  is the probability that bank  $i$  has lent to bank  $j$ . So if we use  $p=0.2$  this means that we will have 20% interconnected graph with  $N$  nodes. The number of connections will be equal to  $Z = N*(N-1)*0.2$ .

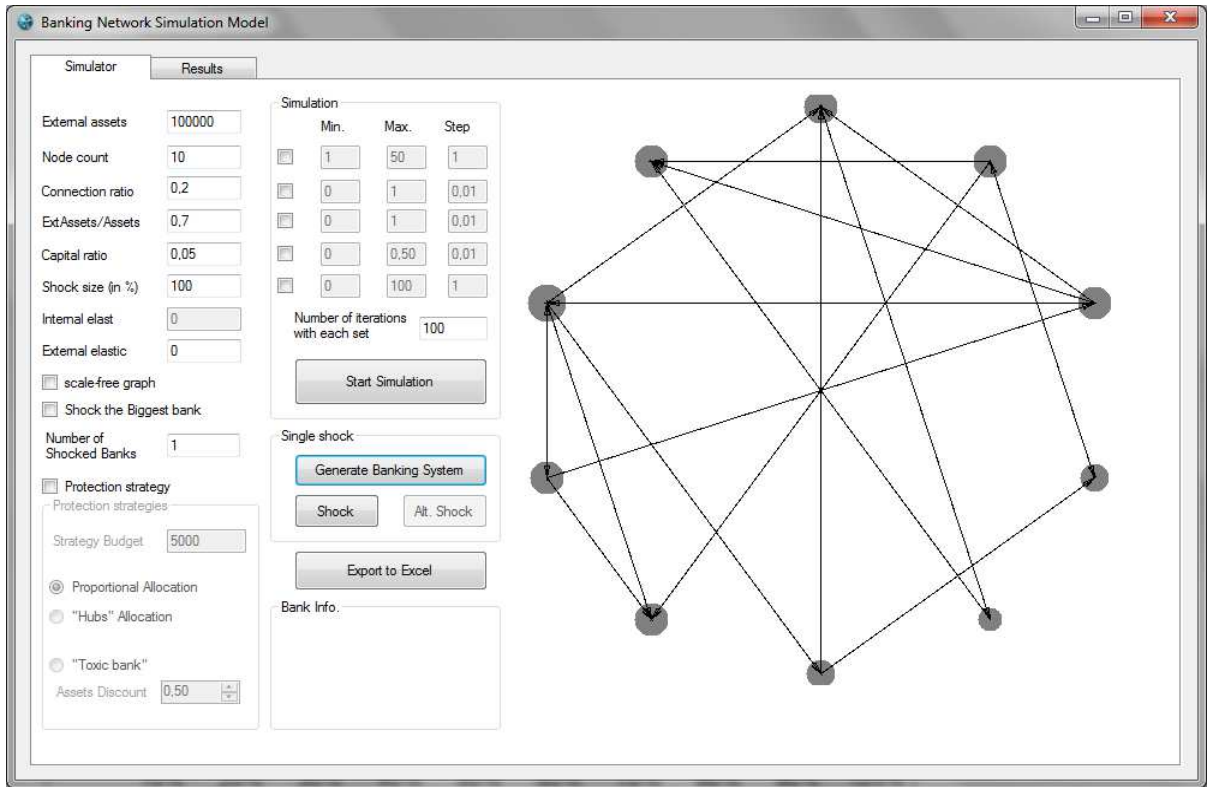


Chart 2.1 - Simulation model interface – written on Microsoft Visual C# Express.

The next thing to do is to fill the balance sheets of all banks.

We denote the individual bank assets by  $a$ . So  $a_i = e_i + i_i$  where  $e$  is the external assets i.e. loans and other investments to non-bank counterparties, and  $i$  denotes the interbank assets, i.e. exposures to other banks in the system.

On the other side of the balance sheet we have the liabilities, denoted by  $l_i$ , so  $l_i = c_i + d_i + b_i$ , where  $c_i$  is the capital of bank  $i$ ,  $d_i$  are the deposits (from non-bank customers) of bank  $i$ , and  $b_i$  denotes the borrowings (from other banks) of bank  $i$ . As every balance sheet,  $a_i = l_i$ . The interbank assets  $i$  of one bank are the borrowings  $b$  of another – these linkages will be used as a shock transmitting channel.

We generate the banks' balance sheets by starting with the external assets of the banking system as a whole ( $E$ ). Then we choose the percentage of the external assets in the total assets of the banking system ( $A$ ). The proportion is  $E/A$ . Knowing that  $A = E + I$ , where  $I$  is the total interbank assets in the system and having  $E$  and  $E/A$  as an input, we can find  $A$  and  $I$ .  $A = E / (E/A)$  and  $I = A - E$ .

Now, knowing the total size of the interbank exposures, we calculate the weight of each link by dividing  $l$  to the total number of links:  $link = l_i / Z$ . From there we can find the individual bank's interbank assets and borrowings by multiplying  $link$  to the number of outgoing and incoming connections to each node (bank) in the graph.

To find the external assets  $e$  we use a two-step approach. We know that the assets side should be equal to the liabilities side:  $e_i + i_i = b_i + c_i + d_i$ . So, to have positive capital and deposits we need  $e_i + i_i \geq b_i$ . First we take  $e_{int} + i_i = b_i$ , where  $e_{int}$  is the interim value of the external assets of a bank. On the second step we distribute the remaining external assets equally to each bank:  $e_i = e_{int} + (E - \sum e_{int})/N$ .

The bank's capital  $c$  is set as a percentage of the bank's assets ( $c_i/a_i$ ). This proportion is an input to the model and it is close to the supervisory capital adequacy ratio (CAR):  $c_i = (e_i + i_i) * (c_i/a_i)$ .

The final balance sheet item – deposits – fills the remaining gap in the liabilities side:

$$d_i = e_i + i_i - b_i - c_i.$$

So initially we construct the model's banking system by using the following inputs:

$N$  – number of banks;

$p$  – probability of connection (between 0 and 1; 0 means that no bank has connections to other banks; 1 means that each bank has connections to all other banks);

$E$  – total external assets of the system;

$E/A$  – percentage of the system's external assets to the system's total assets;

$c_i/a_i$  – percentage of the bank's capital to the total bank's assets.

### 2.2.1 Shock simulation

The shock that we simulate is individual, hitting one bank at a time. Although most of the external shocks would affect several or all banks simultaneously (like a credit risk), hitting one bank (which is common for operational risks) will give us a clear view of the knock-on effect of the shock, transmitted throughout the system. At this stage of the model, the shock affects the banks' solvency and we assume perfect liquidity, i.e. the shocked bank could sell all its remaining assets without any price reduction and repay its obligations up to the amount of assets in disposition, as well as perfect information symmetry, i.e. excluding the information contagion effect. Both liquidity and information effects could amplify the simulated contagion in the paper.

The shock reduces by certain percent the external assets of the bank, showing that the initial shock is external to the system. Further, the shock is transmitted through the interbank assets and borrowings of the banks, internalizing the shock to the system. When the shock is introduced to the banks, the capital is the first to absorb the losses:  $s - c$ , where  $s$  is the size of the shock. If the shock is greater than the capital  $s > c$  then the bank defaults and the borrowings are the next to absorb the losses:  $s - c - b$ . If the shock is big enough to wipe out all borrowings, the final absorber is the customer deposits:  $s - c - b - d$ . The amount of the shock transmitted to the banks to which the shocked banks have links is limited to the amount of the borrowings (*Chart.2.2.*). So if the shock could be absorbed by the banks' borrowings, the transmitted shock would be  $s - c$ . If it is bigger than the borrowings, the transmitted shock would be the whole amount of  $b$ . The shock for the bank's neighbors depends on the link weight (size of each interbank exposure), but since all links in the model at this stage have the same weight, we will be calculating the shock simply by dividing the shock to be transmitted by the number of incoming links (the number of banks which have lent to the shocked bank)  $s_{new} = (s - c) / k$ , where  $s_{new}$  is the shock to be transmitted to one of the creditor banks and  $k$  is the number of creditor banks. The banks from the second round effect first absorb the shock by

their capital and if it is not enough – with their borrowings, and distribute further shock along the connecting links. This procedure is repeated until there are no new defaulted banks.

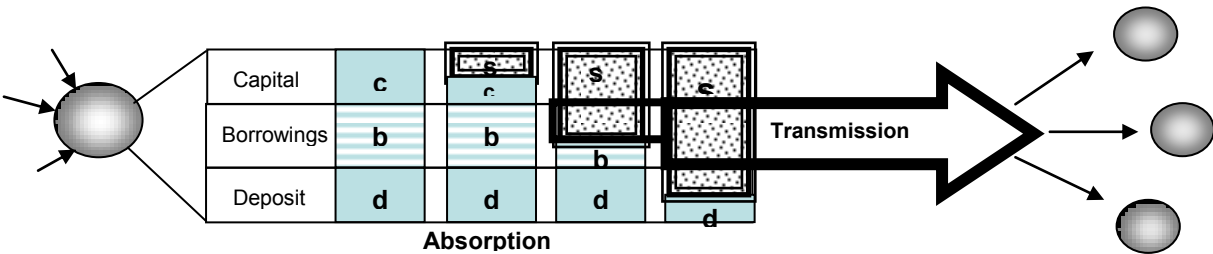


Chart 2.2 – Shock absorption and transmission

For each simulation we change one of the parameters within certain limits. When the graph representing the banking system is random, we make 100 runs with the same setting but with a newly generated graph and calculate the average number of defaults for all the iterations, and then we change the step and make again 100 iterations and so on. By so doing we avoid a biased result if the randomly generated graph isolates the shocked bank by making strange connections pattern.

First we will see how the size of the shock is affecting the banking system. This means to what extend the banking system is resilient to certain amount of shock, transmitted through the interbank linkages. The size of the shock is measured by percentage of the external assets of the initially shocked bank.

We use the following fixed values for the model parameters:  $N = 10$ ;  $p = 20\%$ ;  $E = 100\,000$ ;  $E/A = 70\%$ ;  $c/a = 5\%$ ; and we change the shock between 10% and 100%.

### 2.2.2 Simulation results

While increasing the shock, the extent of contagion is also increasing to a certain point where the shock is distributed to enough banks so it could be absorbed. This mechanism depends on the level of bank interconnectedness. In a more connected banking system the contagion effect is greater (*Charts 2.3a and 2.3b*). Nevertheless, the contagion pattern is different: while the shock is relatively small,

the more connected network is absorbing the shock better as it is distributing small fractions of the shock to many neighbors. But after a certain point the effect of contagion is prevailing over the effect of diversification and the contagion sequence rolls over. After a certain point of saturation the increase in the size of the shock is not provoking additional failures because the shock is distributed to sufficiently many nodes in the system.

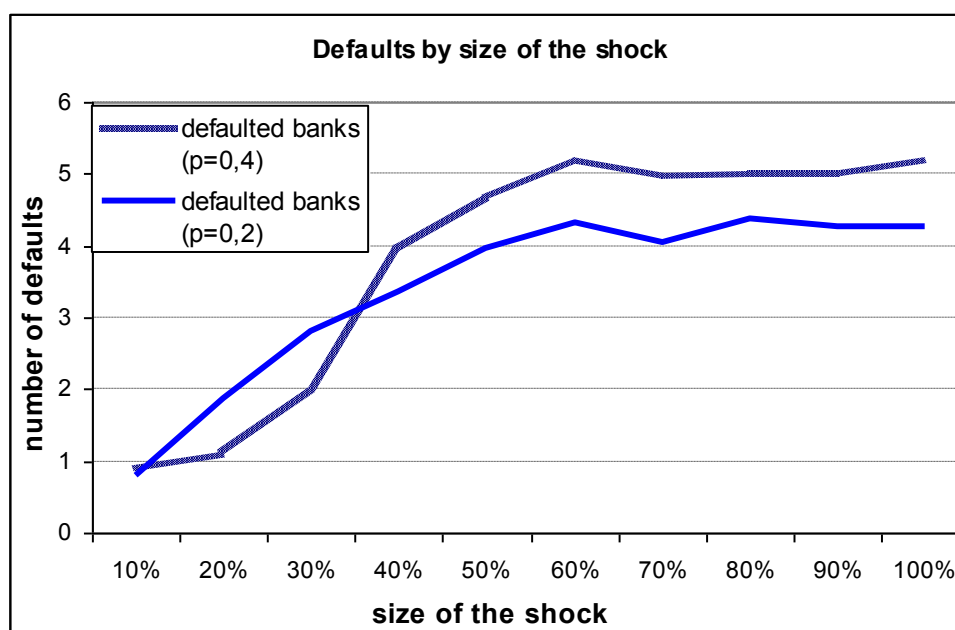


Chart 2.3a – Defaults by size of shock and connection probability

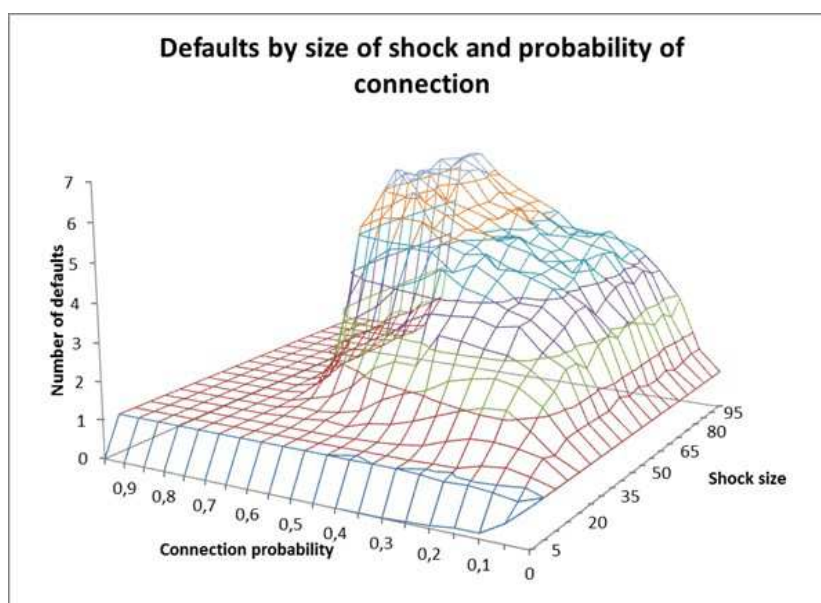
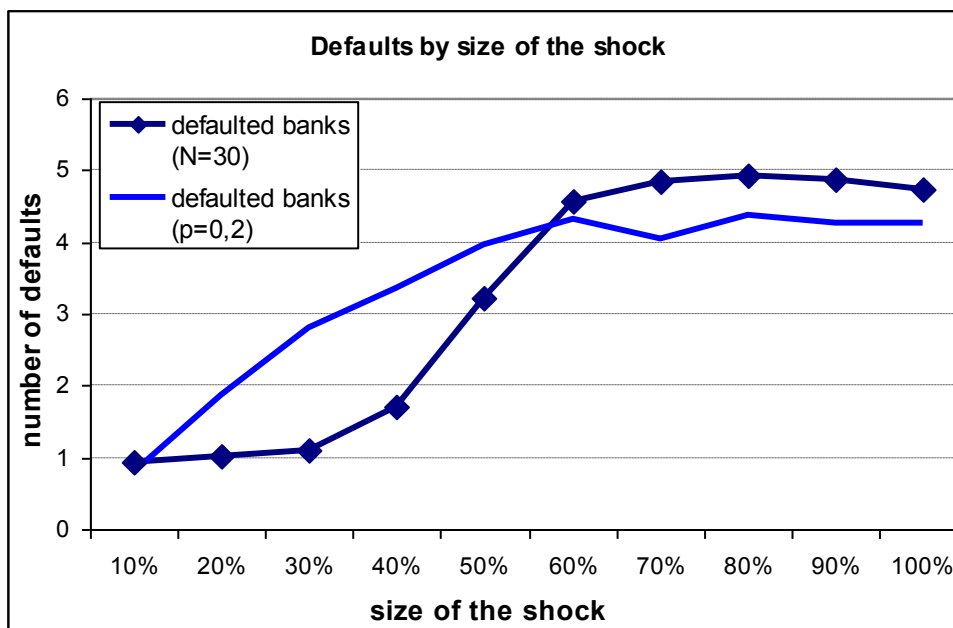


Chart 2.3b – Defaults by size of shock and connection probability



The change in the level of concentration in the banking system is giving us a similar effect as the increase in its interconnectedness. We compare two systems, with 10 and 30 banks. By having more banks we acquire more linkages and greater possibility of contagion (*Chart 2.3c.*). Despite this similarity we have different levels of saturation, so when we have more banks in the system, the absolute number of banks affected by the contagion effect will be higher, but as a percent of the total number of banks we will have lower default levels.



*Chart 2.3c – Defaults by size of shock and number of banks*

The different capital levels also strongly affect the contagion behavior. When the banks have fewer capital buffers they are more prone to contagion (*Chart 2.3d*). This could be due to a riskier business model or due to previous shocks which affected certain or all banks in the system.

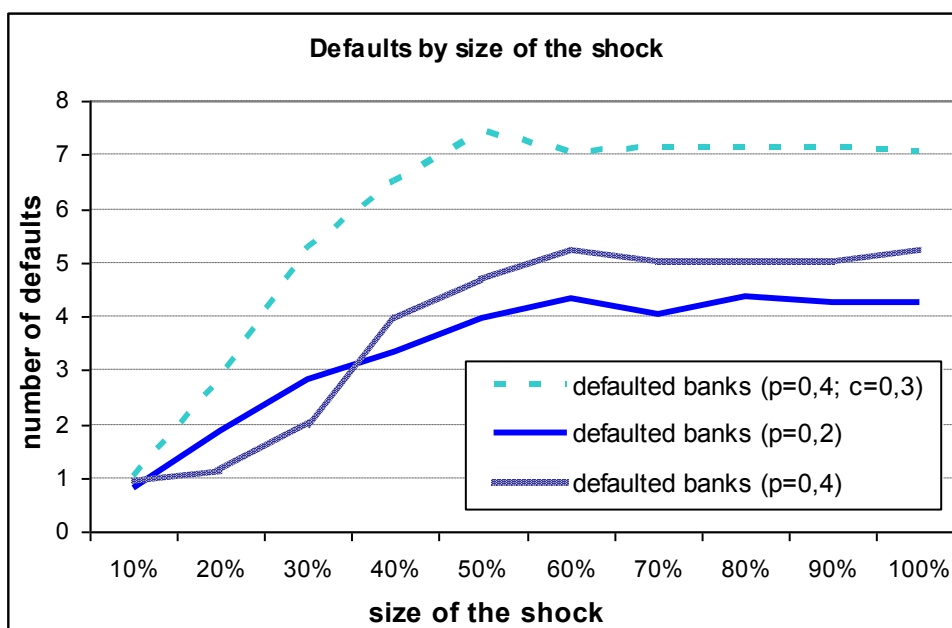


Chart 2.3d – Defaults by size of shock, connection probability and size of capital

The portfolio structure of the banks' assets also affects their contagion sensitivity. A banking system with more interbank exposures and less exposures to non-financial entities will have lesser chance for external shock (and initially the effect of diversification will be stronger), but the higher weight of the interbank linkages allows them to transmit more stress to their neighbors in the system, and in a situation with a higher size of the initial shock, the number of defaults will be also higher (Chart 2.3e).

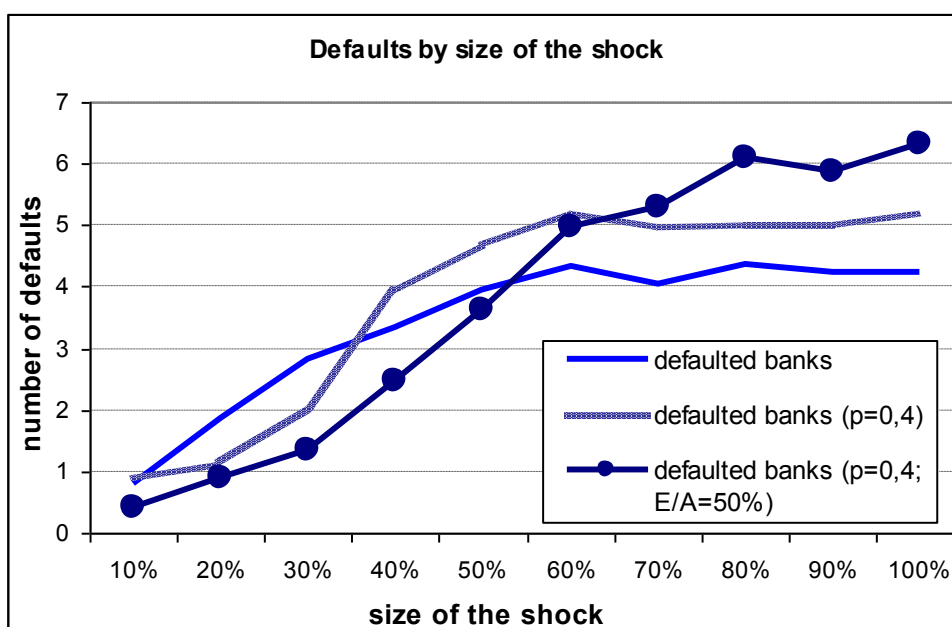
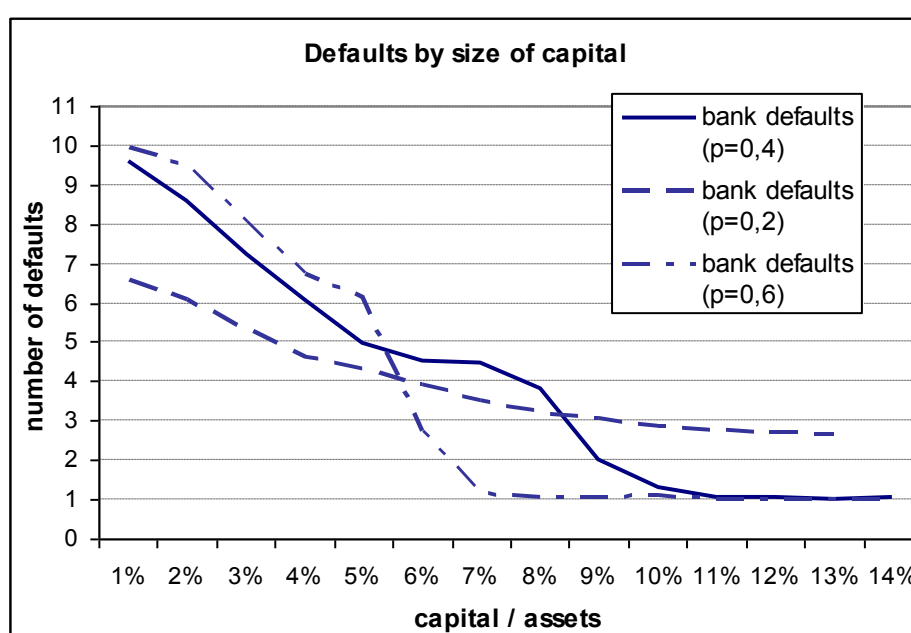
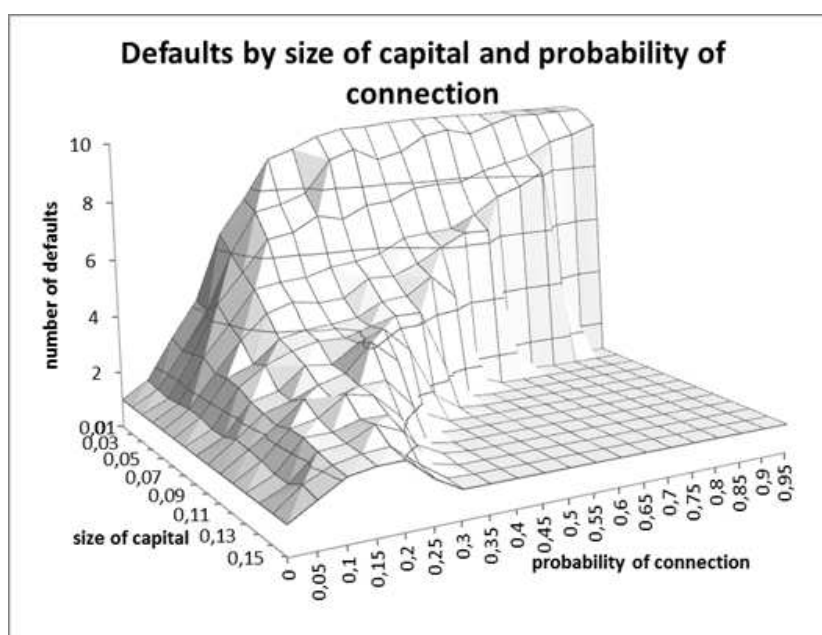


Chart 2.3e – Defaults by size of shock, connection probability and size of external assets

From *Charts 2.4a and 2.4b* we can clearly see that the capital buffers play crucial role in the banks' stability. The relationship between the capital levels and the contagion effect is clearly negative. When the capital is set to 1%, almost all of the banks fail, but as the capital increases, the contagion effect becomes weaker. After a certain level of capital the banks are resilient to interbank contagion because the shock is distributed to sufficiently large number of banks, and only the initially shocked bank fails. The contagion behavior is affected also by the level of interbank connections. A less connected network could initially suffer less damage from an external shock as the contagion paths are fewer, but on the other hand, if the shock spreads, the system will need more capital to absorb the losses. A highly interconnected system has greater chances of contagion but the more links it has, the more the effect of diversification is prevailing so the banks could absorb the shock with less capital needed. The lower level of capital could be explained by riskier business models, by previous shocks which affected certain or all banks in the system, or by moral-hazard behavior in a situation where the government has announced explicit engagement to bail out any troubled bank.



*Chart 2.4a – Defaults by size of capital and connection probability*



*Chart 2.4b – Defaults by size of capital and connection probability*

The effect of the portfolio structure is shown on *Chart 2.5*. Initially, when the interbank assets prevail, the effect of diversification is stronger than the effect of contagion. By increasing the external assets we increase the size of the potential shock and thus the number of defaults goes up. At certain point the level of interbank exposure goes low enough, the system is practically disintegrated, the shocked bank stays isolated and the contagion mechanism becomes ineffective.

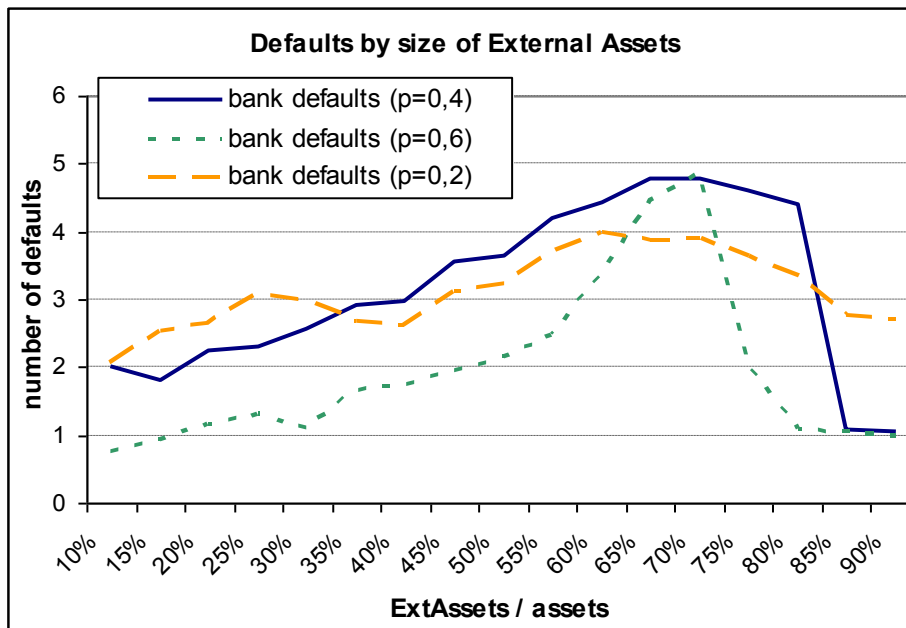


Chart 2.5 – Defaults by size of external assets

The structure of the banking network has an important role in defining the contagion behavior. We have a reversed u-turned curve (*Charts 2.6a and 2.6b*). While the system is practically not integrated (the probability of connection is 0%), the shock cannot spread and only the shocked bank fails. With the increase of interconnectedness the contagion effect also increases to the point where we have enough connections so that the diversification effect could outweigh the contagion by distributing the shock to sufficiently high number of banks. We can see that a complete system (with high enough probability of connection) is capable of absorbing the shock and again only the initial bank fails. The threshold (the equilibrium between the contagion and diversification effects) depends on the banks' profiles. A banking system with fewer buffers (for example capital) will suffer higher damage in terms of failed banks because a greater amount of shock will be transmitted between the banks and the system will need a higher level of interbank linkages to survive and absorb the shock. We can draw the conclusion that the lower level of capital or other buffers increases the destructive power of the interbank linkages, and in a banking system with more capital buffers, the interbank linkages will be more shock-absorbers and less shock-transmitters, thus improving the system resilience.

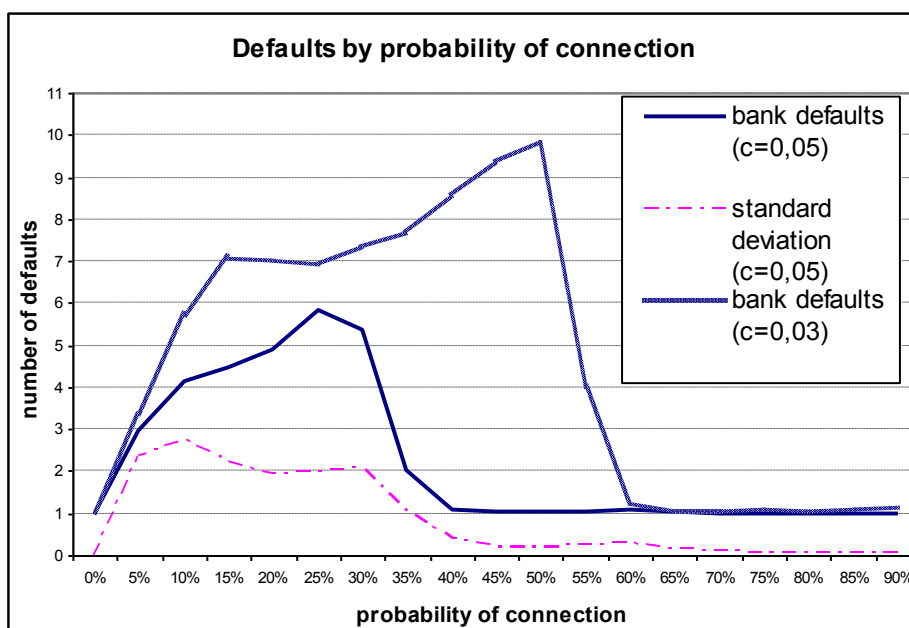


Chart 2.6a. – Defaults by connection probability and size of capital

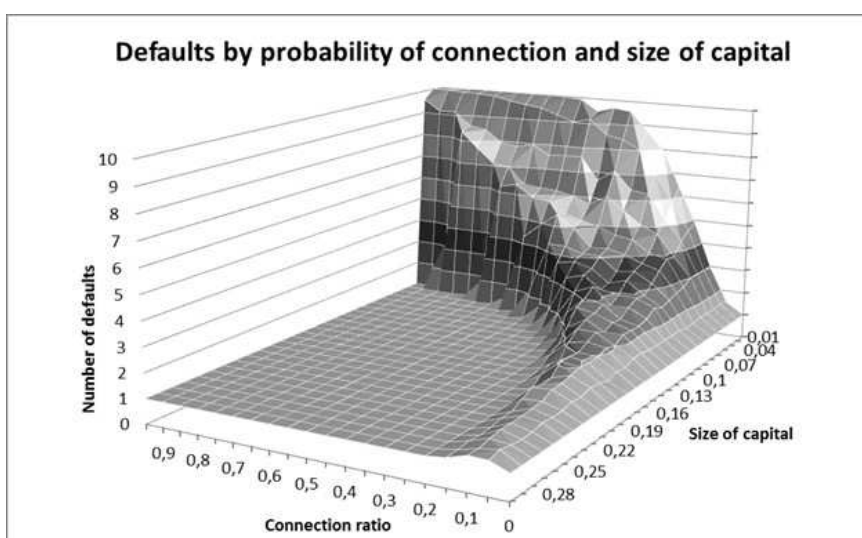


Chart 2.6b. – Defaults by connection probability and size of capital

## Mark-to-market accounting

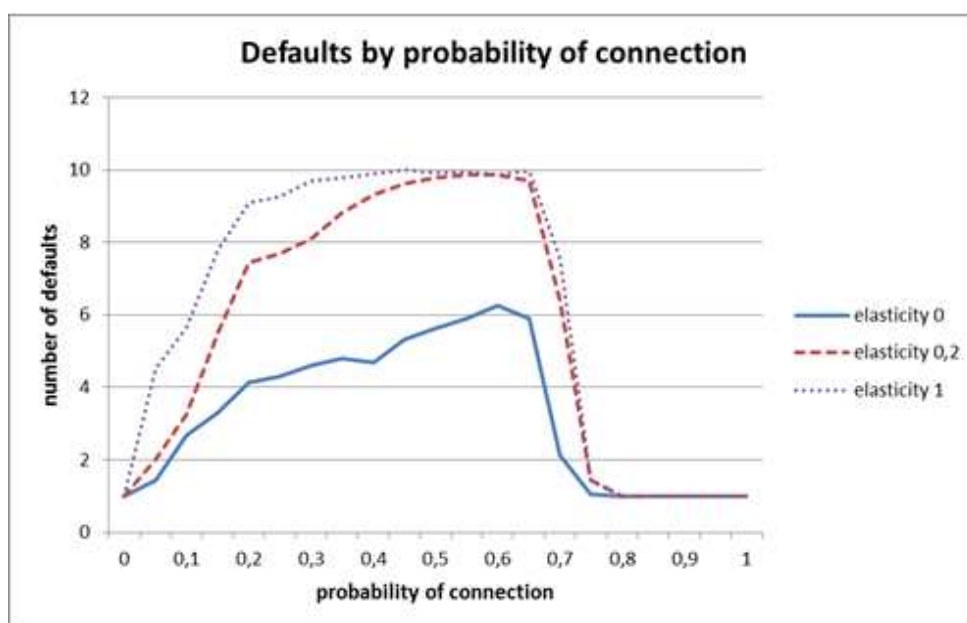
So far we have made all simulations under the assumption of perfect market liquidity. Now we will introduce the liquidity effect described by the elasticity of the assets' price to the assets sales and the mark-to-market accounting effect to the banks' balance sheet accounts. Under the new framework the assets' price is decreasing with the same proportion as the assets sold on the market compared to the total assets in the system. We are introducing a coefficient *elasticity*, which is

affecting the magnitude of the liquidity effect. Value of 0 means no liquidity effect or perfectly inelastic asset price (perfect liquidity), and 1 means full liquidity effect or unitary elasticity of the asset price.

$$\% \text{ of change in assets price} = 1 - \text{elasticity} * (a_{\text{sold}} / A)$$

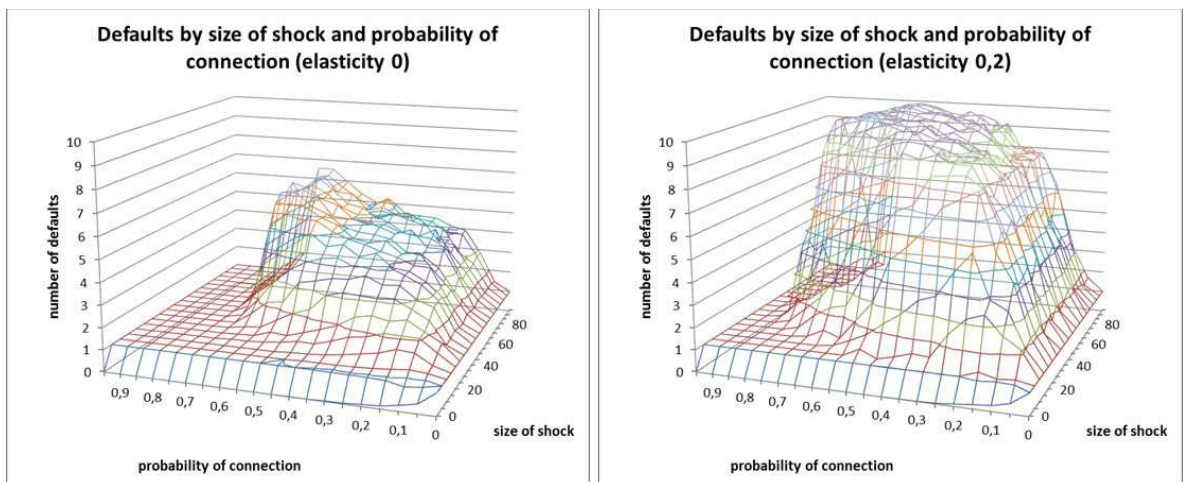
By introducing the mark-to-market accounting principle, the banks' assets are revaluated on each simulation cycle, taking into account the current market price of the assets. This means that when a bank defaults it sells all its remaining assets and exerts pressure on the assets' prices. In parallel with that, the balance sheets of all other remaining banks are revaluated and the amount of assets is decreased in accordance with the new prices. The effect of the mark-to-market accounting principle is that it brings additional shock to the system, weakening all the banks. This shock cumulates over the balance sheet contagion effect and amplifies it.

The contagion profile with mark-to-market accounting resembles the contagion profile of a less capitalized banking system (*Chart.2.7.*). We have a higher number of defaulted banks in any configuration of the network (level of interconnectedness of the graph).



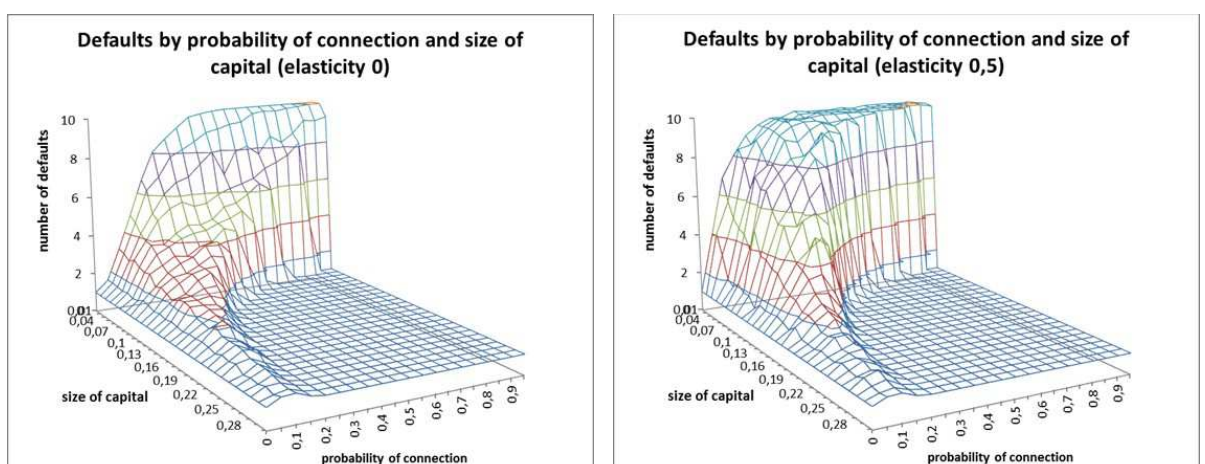
*Chart 2.7. – Defaults by probability of connection and liquidity effect*

Under this effect we are witnessing earlier defaults even when the shock is relatively small (*Chart.2.8.*). The diversification effect starts prevailing on a later stage, i.e. the banking system needs more interbank linkages to distribute the shock to a sufficiently large number of banks so that the contagion effect could be overcome.



*Chart 2.8 – Defaults by size of shock, probability of connection and liquidity effect*

With the same level of initial shock the banking system needs more capital to withstand the contagion sequence. The liquidity effect is causing higher defaults levels in equally capitalized banking systems (*Chart.2.9.*).

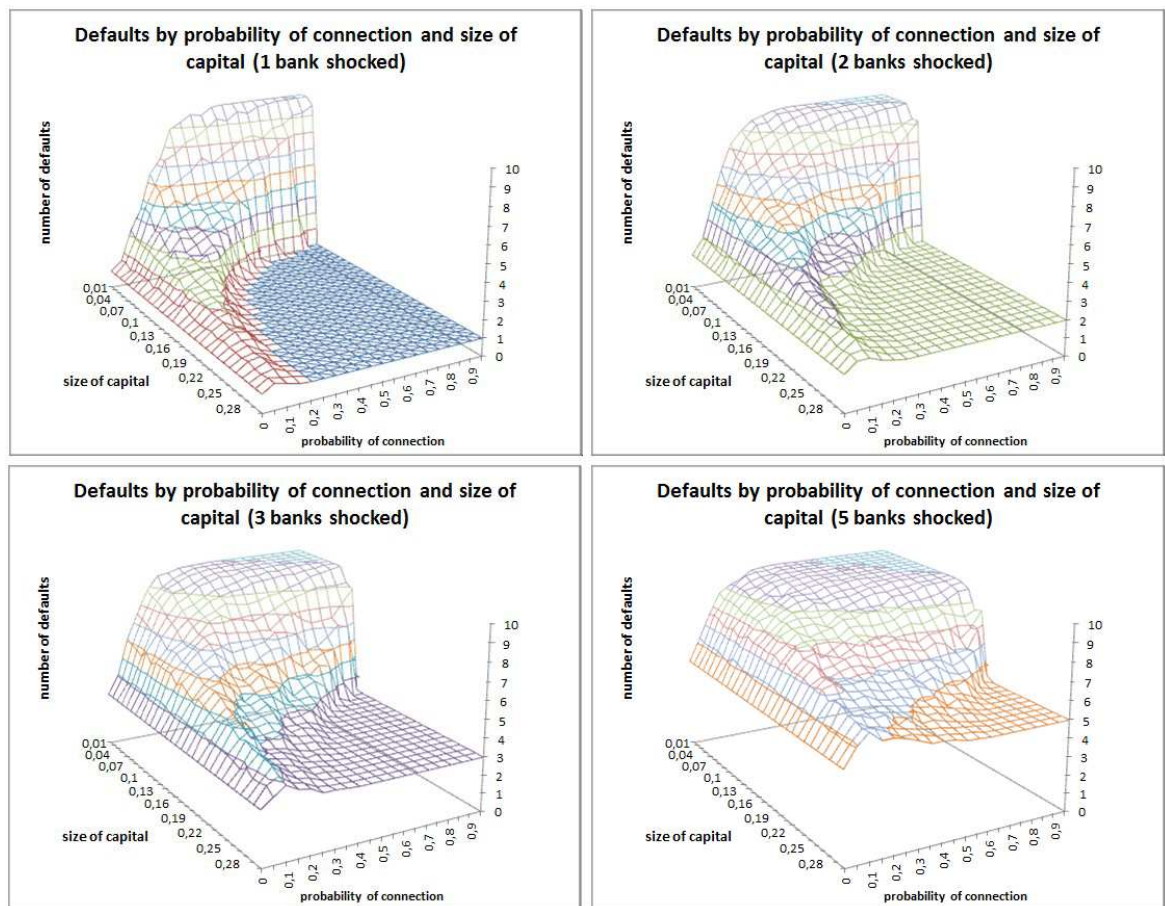


*Chart 2.9 – Defaults by probability of connection, size of capital and liquidity effect*



## Systemic events

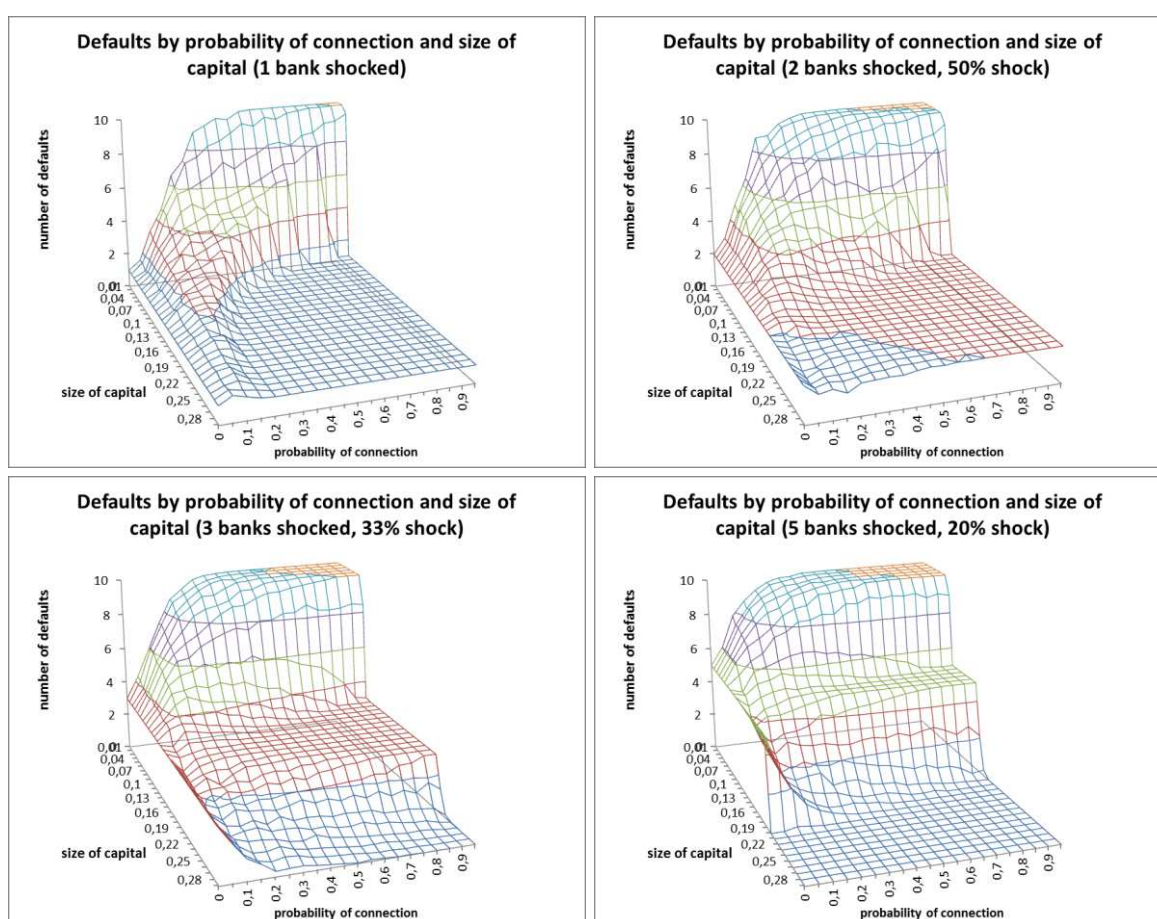
All the simulations so far have been made by initially shocking one bank. Nevertheless, most external shocks would affect several or all banks simultaneously. In the model we are introducing the ability to shock several banks at the beginning of the simulation. The contagion profile shows how vulnerable and fragile a banking system is (*Chart.2.10*). We see that by increasing the number of initially shocked banks we get a stronger contagion effect (wider contagion area). This is mainly due to the greater shock, introduced to the system. To withstand a systemic shock the banking system needs to be better capitalized and more interconnected.



*Chart 2.10. – Defaults by probability of connection, size of capital and number of shocked banks*

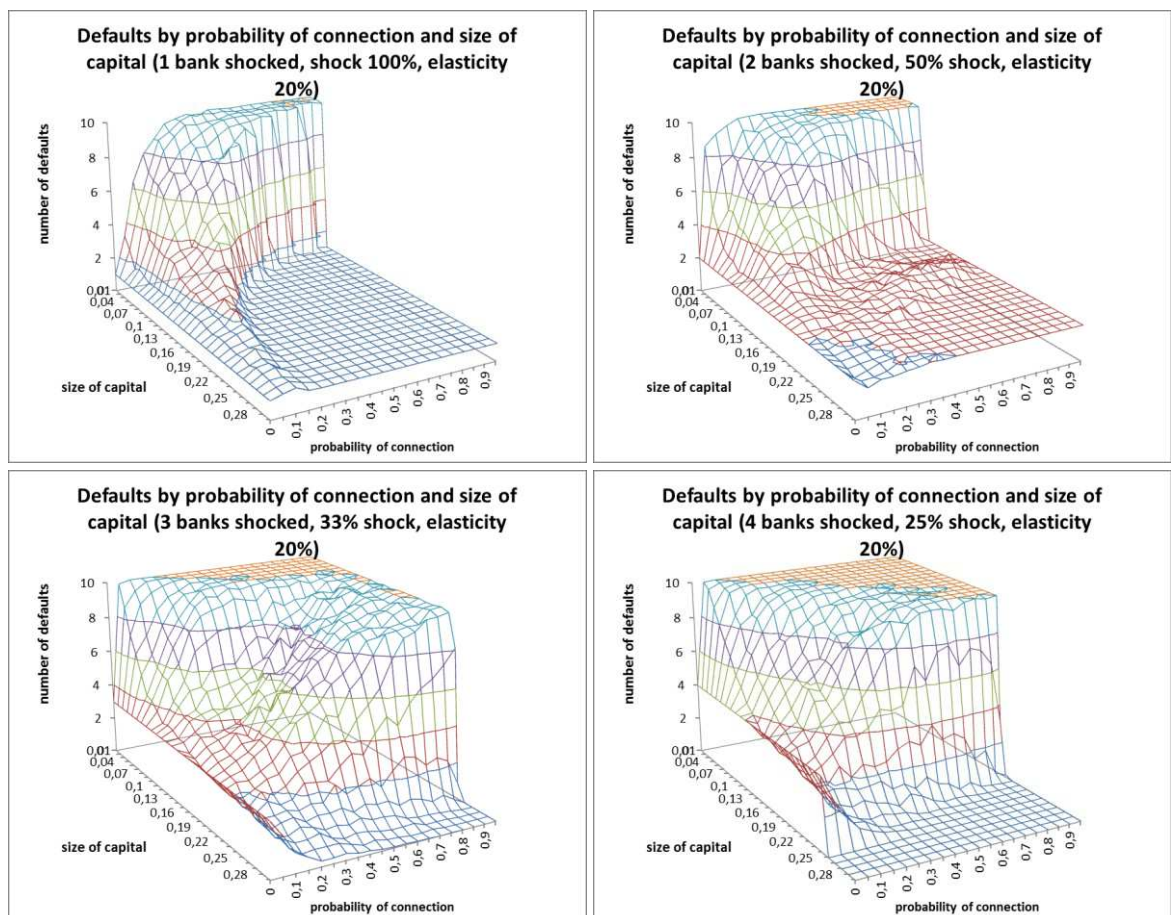
To better reveal the behavior of the banking network, we are conducting a similar simulation, but this time maintaining a relatively identical size of the shock in

the different scenarios i.e. increasing the number of initially shocked banks while decreasing the shock size for each bank. We can see a slight increase in the contagion area (*Chart.2.11*) due to the fact that the initial shock is spread to more banks and thus we have more contagion channels. By further increasing the number of initially shocked banks, the relative size of the shock for each bank is getting smaller and we see a new three-staged contagion profile. First, when the banks have lower capital buffers, the contagion effect works and we have high number of defaults. At some point, by increasing the banks' capital, the effect of diversification starts prevailing and the number of defaults is limited only to the initially shocked banks. By further increasing the capital level, having in mind that with a high number of initially shocked banks the size of the shock is relatively small, the banks are getting able to withstand the shock and the system scores no defaults.



*Chart 2.11 – Defaults by probability of connection, size of capital and number of shocked banks, maintaining fixed shock size*

By introducing the mark-to-market accounting principle we see again a new contagion profile. By increasing the number of shocked banks while holding the total size of shock identical, this time the contagion area expands rapidly (*Chart.2.12*). The liquidity effect amplifies the contagion effect. With greater number of initially shocked banks we do not observe the three-staged profile anymore. Instead of that, having lower interconnectivity, the number of defaults increases gradually while the banks are getting less capitalized. In a higher interconnected network the transition is more rapid – we observe a certain break point where the banks can no longer withstand the initial shock and the contagion effect is leading to a rapid system breakdown.



*Chart 2.12 – Defaults by probability of connection, size of capital and number of shocked banks, maintaining fixed shock size and including the liquidity effect*

### 2.2.3 Ways for improving the network approach for ensuring stability and efficiency of the banking system

Until recently, the banking system was considered as a set of financial institutions competing in a specific market – the banking market. In this respect, their role was not considered different from any other market player on the financial and non-financial markets. When a bank fails, the law provides protection to the creditors and in most cases to those who have entrusted their money to the banks – the depositors. But the crisis has shown us that the disturbance occurring in the financial market is rapidly transmitted to the rest of the economy. All entities relying on the banks' services for conducting their businesses are also affected adversely. The social function of the banks comes into focus - their role as financial intermediaries in the economy. The significance of this function is increasing more and more. The banking system can be seen as a meta-infrastructure. It is the economic infrastructure connecting the market participants in the economy and facilitating the processes of financial resources transformation.

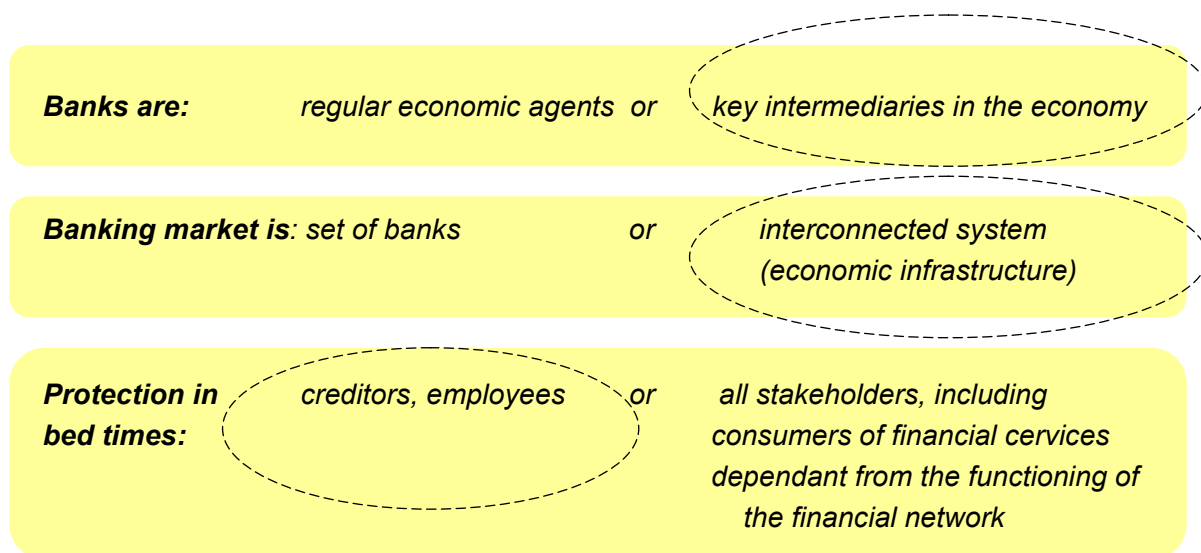


Chart 2.13 – Today's banks

The financial markets are largely integrated, but the institutions responsible for their supervision and safeguarding the financial stability remain divided along the

national lines. Banking markets are complex network structures. Studies on the stability of financial systems (Allen 2000, Nier 2008) used the assumption that the participants are equal, and the distribution of links is a random – *Chart 2.14(a)*. Studies on economic networks (as are the banking/financial markets) show that their structure is considerably more complex (Lewis, 2009). These networks have the characteristics of scale-free networks<sup>10</sup> and small-world networks<sup>11</sup>. There can be observed a higher level of clustering, where some nodes called "hubs" have much more connections than others. Hubs in the banking system are the systematically important banks. Scale-free networks are networks whose degree of distribution follows a power law – the probability of a node to make connection to other nodes depends on the number of connections, which it owns. On the other hand the radius of the network – the number of hops/links between the two most distant nodes, is relatively small (small world effect) – *Chart.2.14(b)*.



*a) Random network    b) scale-free network*

*Chart 2.14 - Types of networks*

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<sup>10</sup> A scale-free network is a connected graph or network with the property that the number of links originating from a given node exhibits a power law distribution. A scale-free network can be constructed by progressively adding nodes to an existing network and introducing links to existing nodes with preferential attachment so that the probability of linking to a given node is proportional to the number of existing links that node has.

<sup>11</sup> Taking a connected graph or network with a high graph diameter and adding a very small number of edges randomly, the diameter tends to drop drastically. This is known as the small world phenomenon. It is sometimes also known as "six degrees of separation" since, in the social network of the world, any person turns out to be linked to any other person by roughly six connections.



### 2.2.4 Network model results using scale-free networks

In order to bring the simulation closer to reality we modeled a banking system, based on a scale-free network. For this purpose we implemented the Barabasi–Albert algorithm for generating random scale-free networks using a preferential attachment mechanism<sup>12</sup>. The scale-free banking system is prone to stronger contagion effect and the number of defaults rises sharply due to the presence of hubs (*Chart.2.15.*). We can observe a less smooth contagion profile reaching higher number of defaults, showing us the fragility of the financial networks. On the other hand, while increasing the interconnectedness of the system, the defaults are dropping more rapidly than those in a random network.

The overall contagion profile of the scale-free network looks sharper and reaches a higher number of defaults in all system configurations in terms of capital levels (*Chart.2.16.*), especially when the network is less connected. Upon increasing the interconnectedness of the network, the contagion profile is starting to resemble the random network profile, due to the fact that, by increasing the connections, the structure of the graph is gradually losing its scale-free characteristics, turning into a complete graph at the end.

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<sup>12</sup> Preferential attachment means that the more connected a node is, the more likely it is to receive new links. Nodes with higher degree have stronger ability to grab links added to the network.

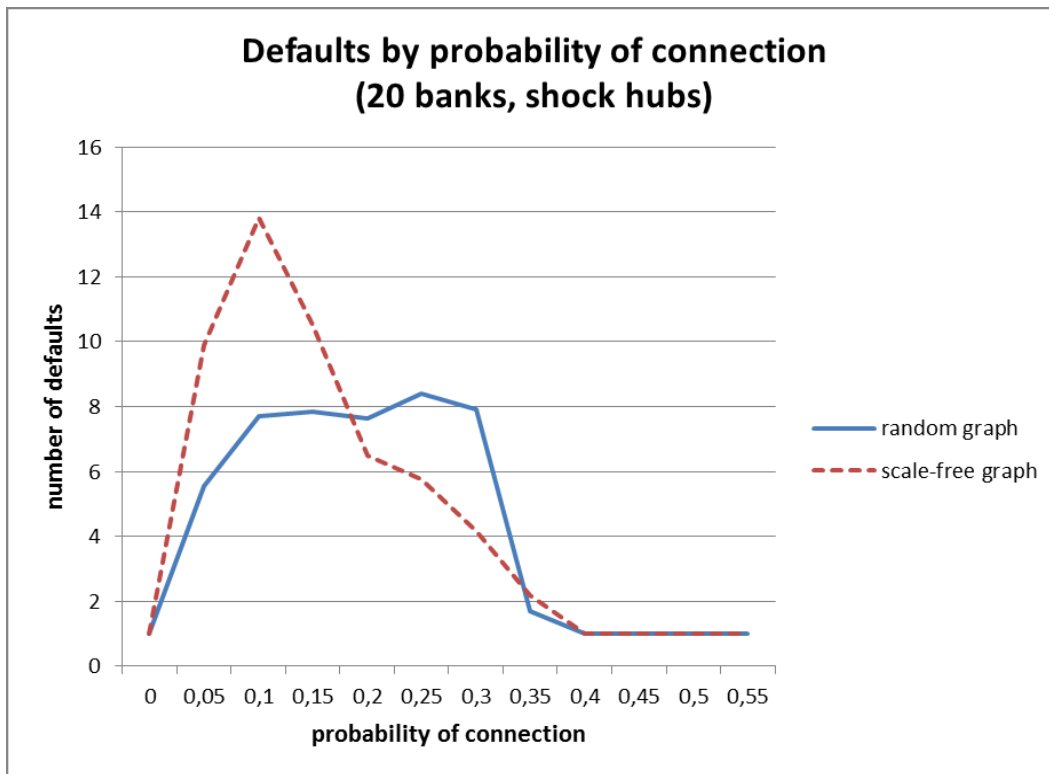


Chart 2.15 – Contagion profile – number of defaults by probability of connection

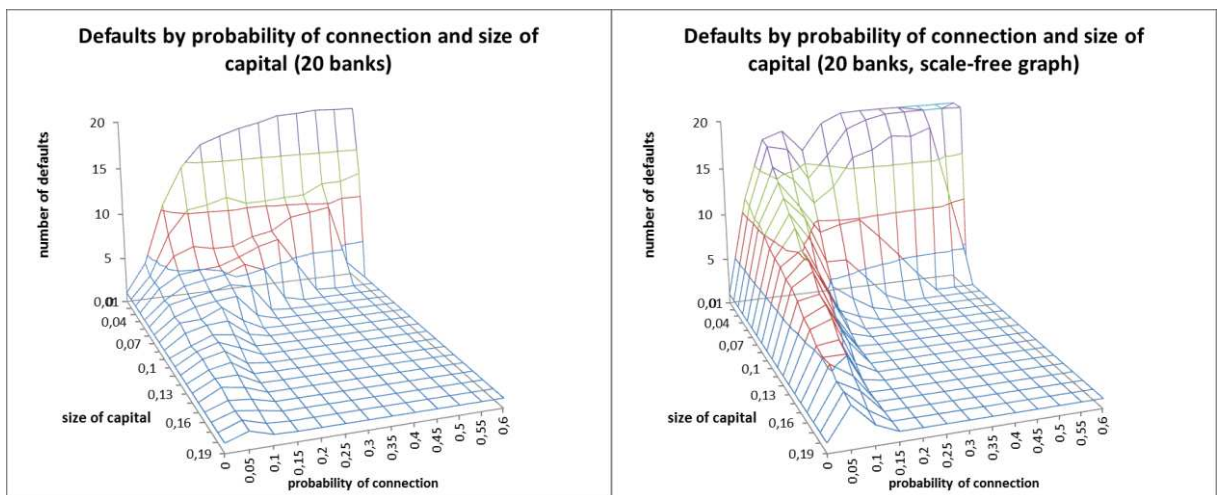


Chart 2.16. - Contagion profile – number of defaults by probability of connection and size of capital

## 2.2.5. Simulation model results for Network protection strategies

In our simulation model we introduced and tested three protection strategies:

The first consists of proportional allocation of bail-out funds to the banks. This strategy resembles a theoretical government bail-out program where the banks' capital is increased.

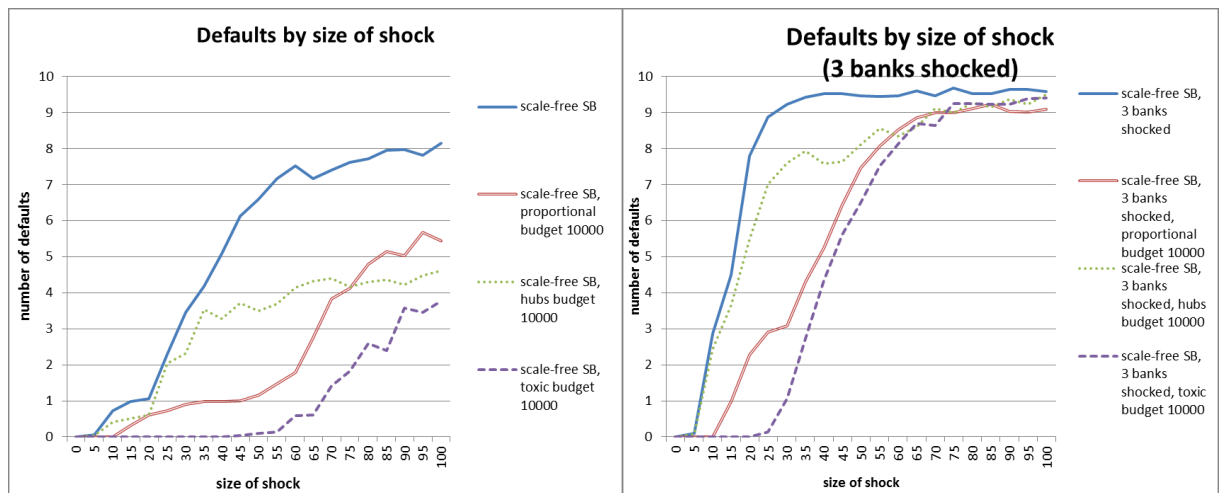
The second one is a derivate of the first, but the bail-out funds are allocated only to the biggest banks (the hubs).

The third strategy is called "toxic bank" and resembles a theoretical government bail-out program, where there is a special institution buying the troubled assets from the banks while applying certain discount ratio. For better comparison we are using an identical budget amount for all strategies.

We can see that the different strategies affect the contagion profile in a different aspect (*Chart.2.17.*). The "proportional allocation" strategy reduces significantly the number of defaulted banks when the shock to the initial bank is moderate. The "hubs allocation" strategy gives an overall lower number of defaulted banks. Nevertheless, this strategy is more effective when we have a full-scale shock. The "toxic bank" strategy turns out to be the most effective. It gives the lowest number of defaulted banks, independently of the shock size, because this strategy is the most flexible – the funds are allocated on a case-by-case basis covering only the troubled banks. Depending on the regulators' or government's policy and the budget limits, a different discount ratio could be applied while buying toxic assets from the banks.

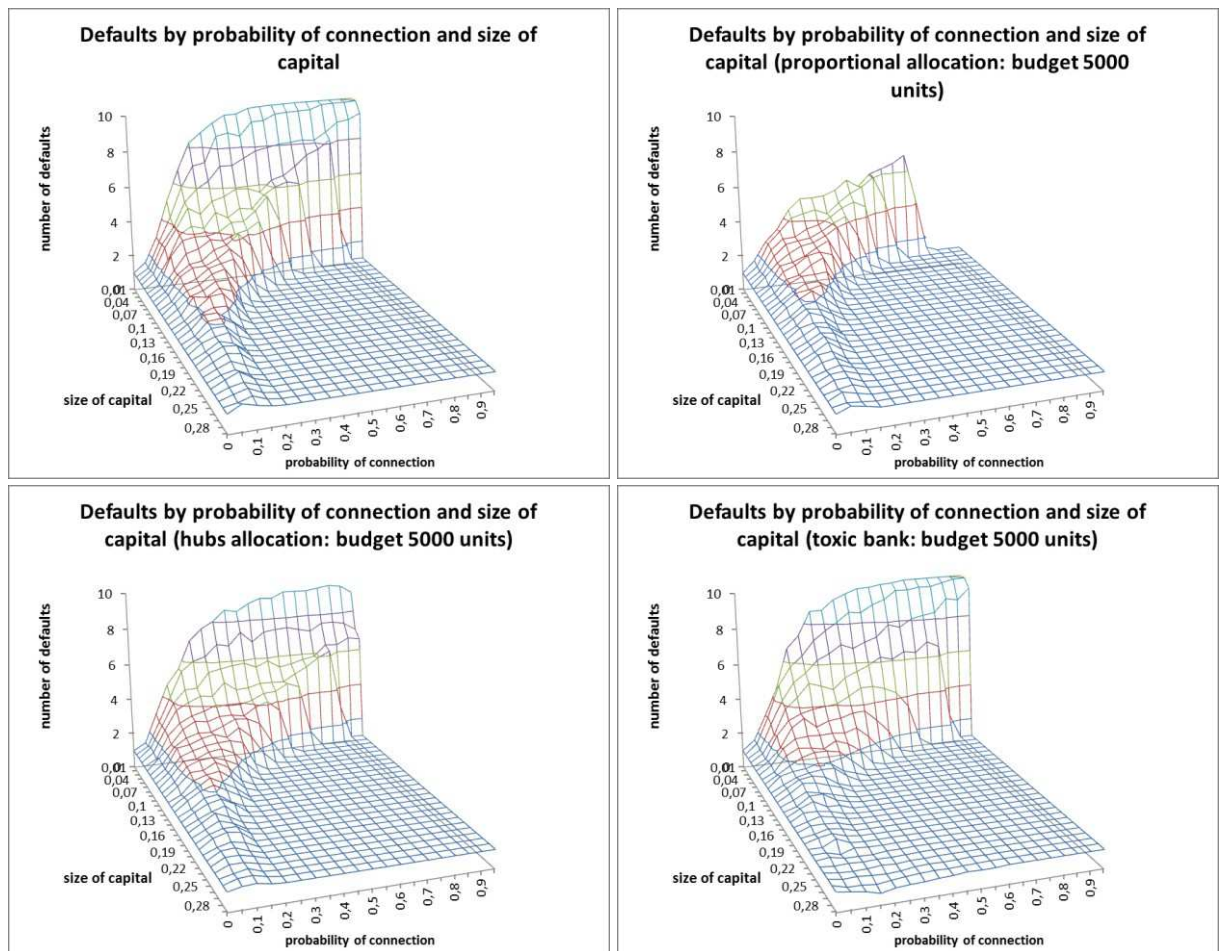
Irrespective of their effectiveness and characteristics, all the strategies are bound with the same budget limits and when the shock gets big enough they cannot save the system entirely (*Chart.2.17.*). If the funds limit is not sufficient to cope with the shock scale, these strategies can only postpone the system breakdown and give enough time for the economists and politicians to engage in more serious reforms.





*Chart 2.17 – Contagion profile after protection strategies – defaults by size of shock.*

Looking at the overall contagion profiles of the different strategies, we can notice that the “proportional allocation” strategy is more effective when the system is significantly undercapitalized (*Chart.2.18.*). This is due to the fact that the strategy increases directly the capital base of the banks in the system. The “toxic bank” strategy is more effective with moderately capitalized banks because it reduces the toxic portfolios without affecting their capital.



*Chart 2.18 - Contagion profile after protection strategies – number of defaults by probability of connection and size of capital*

### 2.3. Conclusions from the use of network models for analysis of the banking system

- 1) The simulation model developed using graphs and algorithms for economic parameters calculation and the propagation wave of the shock in the banking system show an adequate behavior in the sense that the simulation results are easily explicable in terms of parameters and financial and economic dependencies. The model shows that the behavior of a banking network is predictable and there are a limited number of influence parameters that are measurable and even controllable. The model reveals that the stability of the system depends not only on the individual bank's stability, but also on the

intensity and the size of interbank linkages, i.e. how integrated the banking market is.

- 2) The results obtained show that the implementation of the network approach to the banking system offers interesting opportunities for reorganizing its structure and predicting its response in crisis situations. This would contribute to the financial system transformation recommended in 2009 by the “la Rosière” group, and for the establishment of a new system for European financial regulation and strengthening the cooperation and coordination between national supervisors.

### **Chapter III - THE PLACE OF BULGARIA IN THE TRANSITION TOWARDS THE SINGLE EUROPEAN BANKING MARKET**

Bank assessment is often conducted using information on realized profits, but excluding such indicators as efficiency<sup>13</sup> and quality of the final product/service. The most used analytical method is the quantitative analysis of the financial indicators and financial ratios analysis (for example the CAMELS<sup>14</sup> model and others). These techniques result in a variety of types of outcomes, which brings the need for further calculation and interpretation for deriving an overall assessment indicator.

For analyzing the development of the banking system it is necessary to take into account its efficiency as one of the main indicators. In this process of development significant contributions are the privatization, foreign banks entry, competition, liberalization, change in legislative environment and institutional rules, technologies and new knowledge, changes in the macroeconomic environment and others. Computing the efficiency scores for Bulgaria allows us to make comparison with other banking systems.

In the recent years numerous comparative analyses of particular banks and banking systems in the EU Member States as well as in the developing countries have been carried out. These researches use parametric and non-parametric methods for assessment (Daniel Hollo, Marton Nagi, 2002) and Stochastic frontier approach (Yildirim and Philippatos, 2002). With these tools one can measure the influence of privatization processes on bank performance (Bonin, Hasan and Wachel, 2004a, 2004b; Athanasoglou et al., 2006) and the influence of foreign banks entry and foreign ownership with controlling power on bank efficiency (Havrylchuk and Jurzyk,

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<sup>13</sup> Comparison between the actual and optimal values of input and output parameters. The different types of efficiency reflect different definitions of the optimum.

<sup>14</sup> Capital, Asset Quality, Management, Earnings, Liquidity, and Sensitivity (CAMELS) - A rating system for the bank's overall condition. The CAMELS rating is based on financial statements of the bank and conclusions from on-site examinations, conducted by the supervisory authorities. Usually these ratings are not public.

2006). It is very useful to calculate certain aspects of the banking efficiency, such as: operational efficiency (Grigorian and Manole, 2002; Tomova, Nenovsky and Naneva, 2004; Tomova, 2005), inefficiency (average X-inefficiency<sup>15</sup>, average profit-inefficiency<sup>16</sup> or average technological inefficiency<sup>17</sup>), technical efficiency<sup>17</sup> (Nenkova and Tomova, 2003). A significant part of these researches outlines the direct relation between the efficiency and the acceleration of the convergence processes in the Single European Financial Market.

In this sense the task here is to analyze the development of the Bulgarian banking market, the influence of the entry of the bigger European banks into the local market as a form of bank integration, and the comparison of the Bulgarian banking system efficiency with the aggregated efficiency of the Single EU financial market for determining the degree and the speed of the integration processes. As a main instrument we will use the Data Envelopment Analysis (DEA). The calculations will be performed in two steps - with pre-crisis data and on the second step with data up to 2012 year end. The reason is to minimize the distortion effect which the different EU and national stimulus packages, activated after the beginning of the crisis, could impose on the DEA results, regarding that these stimulus were directed mainly to the big financial groups and no Bulgarian banks benefited directly from such liquidity or bail-out funds.

### **3.1. Analysis of the development of the Bulgarian banking market in its transition towards the Single European financial market**

We indicate the main characteristics that play an important role in the development of the Bulgarian banking system.

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<sup>15</sup> Situation when a unit fails to produce on the lowest possible average and marginal cost curves. The X-inefficiency model implies a best-practice technology. No random factor could make a unit's production function better than that best-practice one.

<sup>16</sup> Comparison between the actual and optimal costs, income, profit or other target indicator.

<sup>17</sup> The optimum is defined by the production possibility frontier. The technical efficiency gives a measure of how managers are able to minimise cost or maximise production by input and output allocation.

The transformation of the banking system from one-tier into a two-tier with the Bulgarian National Bank (BNB) on the first and the commercial banks on the second tier was done through the reestablishment of the commercial banks. A new legislative framework was adopted to reflect the new market structure. The Law on the Bulgarian National Bank (1991) defined the objectives and the powers of the BNB. Later the Law on the banks and credit activity (1992) defined the activities banks could perform under the license they were granted. Further, almost all banks were transformed into universal banks offering deposit and credit services to all customers. The branches of the BNB were also transformed into commercial banks (keeping in mind that before the transformations the BNB performed almost all of the functions in the banking market acting as a commercial bank and a central bank simultaneously). Later on a consolidation took place in the sector and many regional banks were merged and prepared for privatization. One of the ideas behind these activities was to improve the efficiency of the banks. Many state-owned banks were deemed to be inefficient as their lending policies were not market driven. They were imposed by the government to finance state enterprises, some of which were not in a good financial condition. To overcome this situation and lay the market-driven fundament of the banking market, a Banking Consolidation Company was established in 1992. It was intended to consolidate, restructure and privatize the state-owned banks. The low speed of these processes however led to extending the portfolios of bad loans and endangering the stability of some of the banks. During that time the Central Bank financed largely the affected banks, operating as a lender of first instead of last resort.

Before the crisis, depositors had little interest in monitoring commercial banks because of the implicit and explicit prudential guarantees. The interest rates on loans, although very high at times, did not reflect true credit risk. An OECD analysis points out that until 1996, the commercial credit was expanded to the non-financial sector in Bulgaria to a degree that was unprecedented relative to any other European transition economy. The structure of these credits was not 'healthy' and led to the

accumulation of a large amount of bad loans. State-owned enterprises and banks were rescued in several waves by issuing government securities, which led to increases in the government's internal debt. The situation deepened in 1996 and turned to a full scale financial (twin) crisis.

The crisis started when in 1996 the BNB took five commercial banks, three of which were private, under conservatorship. At that time, Bulgaria was unable to get loans in international financial markets because of insufficient foreign currency reserves that could be used as collateral. The attempt to stop the banking crisis by introducing a deposit insurance scheme was unsuccessful, because it lacked credibility due to the low foreign currency reserves. In addition the BNB started to pursue a restrictive policy towards banks by increasing minimum reserve requirements, raising interest rates and at once selling US dollars to protect the lev exchange rate. The sharp increase in interest rates in the second half of 1996 further intensified the crisis. Foreign currency was increasingly used as a store of value. In February 1997 the lev depreciated by almost 250 per cent. The devaluation was accompanied by a short period of hyperinflation.

In 1997 a currency board was introduced as a tool for stabilizing the economy. New regulations in the banking sphere were adopted and a stricter supervision policy was applied. Also the entry of foreign banks was eased.

In 1996 - 1997, the banking sector was composed of 33 banks including the State Savings Bank and branches of foreign banks. Most of these banks were small and with private ownership. At the beginning of 1997 there were six state owned commercial banks: Bulbank, United Bulgarian Bank (UBB), Expressbank, Bulgarian PostBank, Hebros Bank and Biochim Commercial Bank. Their major shareholder was the Bank Consolidation Company (BCC), which was in charge of bank privatization.

Bulbank, the second largest bank in Bulgaria, was acquired in July 2000 by Italy's UniCredito with an 86% stake and Germany's Allianz with a 5% stake. National Bank of Greece bought a 99.9% stake in the United Bulgarian Bank (UBB), the

country's third biggest bank in terms of assets at that time. Bulgarian Post Bank was originally acquired by Nomura International in 1998, but later was joint-owned by the American life-insurer ALICO (AIG group) and the international private bank group EFG. In 1999 the French group, Société Générale bought Express Bank. The banking privatization process was completed with the sale of Commercial Bank Biochim (now HVB Bank Biochim following its merger with HVB Bank Bulgaria) to Bank Austria Creditanstalt (HVB Group) at the end of 2002 and the purchase of DSK Bank (the former State Saving Bank) by Hungarian OTP Group in May 2003.

Nowadays the banking market consists of around 30 universal commercial banks where 80% of the assets are foreign owned. There remains only one state bank "Bank for Development" which has specific functions. A distinctive feature of the banking system is the high credit growth and aggressive expansion of the larger banks. This trend was softened by the global credit crunch as the possibilities for easy attraction of foreign resources diminished. In the recent years some mergers took place consolidating the majority of banking assets in the larger foreign banks. Another evidence for the strong competition for bigger market share between the banks is the decreasing market concentration (*Chart 3.1*).

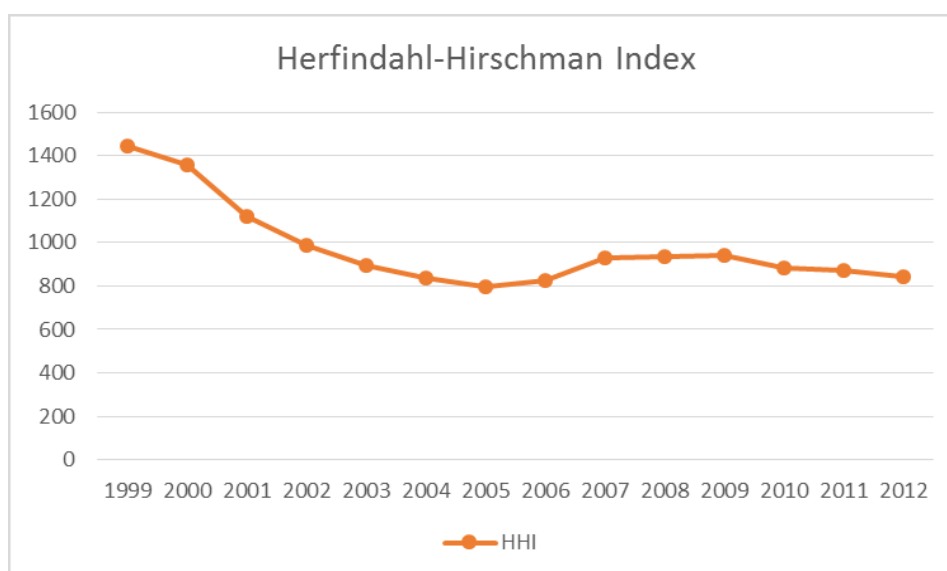


Chart 3.1 – Herfindahl-Hirschman Index



### 3.2. Measuring banking efficiency using the Data Envelopment Analysis

In the past decade the Bulgarian banking market like the other Central and Eastern Europe (CEE) markets experienced strong development due to variety of reasons like foreign bank entry and increasing competition, considerable change in ownership structure through the privatization processes, market liberalization, change in regulatory environment and other factors. All these processes had influenced the bank performance. It is important to analyze whether this development is only extensive, driven by the increase of the banks' portfolios, or is also intensive based on efficiency improvement, which is a very important and crucial issue especially for transition economies.

The Data Envelopment Analysis (DEA) is a methodology for analyzing the relative efficiency of different DMUs (decision making units) using different input and output variables for the model. Generally as input and output variables are used some financial and operating indicators but also indexes and other synthetic indicators could be utilized. The efficiency is relative because the best performing unit is the benchmark for the others and is determining the efficient frontier. The DEA approach involves the use of linear programming methods to construct a nonparametric piecewise frontier over the data, so as to be able to calculate efficiencies relative to this surface (*Annex 3*). In other words, the purpose of DEA is to construct a non-parametric envelopment frontier over the data points such that all observed points lie on or are below the production frontier. The value of efficiency score obtained for any DMU must be less than or equal to one, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU, according to the Farrell (1957) definition.

The model has several advantages and drawbacks. With the DEA approach we can calculate an aggregated efficiency score for each bank using a set of input and output variables, which is one of its advantages over the traditional accounting

approaches. Another advantage of the DEA is that it does not need long time series as the equivalent parametric frontier approaches: Stochastic Frontier Analysis (SFA) and Distribution Free Approach (DFA). One of the main positive sides of the model is that it does not require an assumption for the form of the production function. This allows us to eliminate the risk of wrong specification. Meanwhile the major drawback is that while this approach is non-parametrical it does not discriminate between efficiency score and random error component. It is also sensitive to extreme values of the variables.

Another main advantage of the DEA in comparison with the traditional accounting indicators for efficiency – the operational coefficients ROA, ROE, net interest margin, gross profit margin, expenses / income ratio – is that the latter are biased by different capital structure, services scope and structure, accounting treatment, macro and regulatory environment, etc. In these different conditions, the indicators tend to change in a different way and cannot be used easily for comparing banks from different markets. Thus the possibility of incorporating multiple variables in the DEA model is giving us a single (comparable) measure of efficiency.

The DEA approach has different modifications according to its purpose and the peculiarities of the analyzed units. According to the sensitivity towards the return to scale there are two main modifications: CCR model developed by Charnes, Cooper and Rhodes (Charnes et al. (1978) and BCC model developed by Banker, Charnes and Cooper (Banker et al. (1984). The CCR model (called also: CRS model – constant return to scale model) compares all the DMUs in the sample ignoring the difference in the scale. The BCC model (called also: VRS – variable return to scale model) differentiates the DMU according to their return to scale. It tends to give slightly higher results.

The model could be output oriented or input oriented. To know exactly which modification should be used, we must take a look at the nature of the analyzed units, at the way they are conducting their business. If the unit is trying to maximize the

production given the available resources, then we can choose the output oriented model. And if the unit is trying to minimize the costs for resources given its fixed target for production volume, then we can use the input oriented version of the model.

According to the input and output data, the DEA model has a number of variants. Choosing the input and output variables is essential to the analysis. This choice is connected with data availability and reliability. That is why the analysis of the banking efficiency is a complex task. Relative is the point of view from which the banks are analyzed, whether as producers of financial services or mediators of funds between savers and investors. Also data availability has its own influence.

There are several approaches which had been used in different researches: production approach, operating approach, intermediation approach, value-added approach and others. These approaches are suitable for analyzing different types of enterprises. In the literature on banking efficiency the most commonly used are the operating approach and the intermediation approach. We consider using the intermediation approach for the purpose of this research, as we consider the banks as intermediaries reallocating funds, transforming the attracted funds into credits and securities while incurring different costs like fixed assets, salaries etc.

The empirical results from various researches show that there is no significant difference between the results obtained using the above mentioned methods (SFA and DEA).

For the calculations in this paper we use the prebuilt software: Efficiency Measurement System (EMS) developed by Holger Scheel, Dortmund University.

### **3.3. Efficiency of the Bulgarian Banking System**

For the purpose of the current analysis we use balance sheet and income statement data for the Bulgarian banks for the period 1999 – 2012.

The efficiency assessment is crucial for finding the necessary corrective measures when certain deficiencies are found in the functioning of a bank. This leads for example to finding ways for minimizing the costs or maximizing the income according to the meanings of the target indicators, identified in the process of comparative analysis.

The objects of the analysis are 23 of the banks presented on the Bulgarian market in the period 1999 – 2012. An increase in certain banking indicators, like assets, loans portfolio, the profit and others, is typical for the given period. Logically, the focus should be put on the questions about the quality of this growth, the efficiency of each bank, and about the peculiarities of the development of the Bulgarian banking sector.

We will use Output oriented, variable to scale, DEA with inputs and outputs matching the intermediary approach. We consider that the banks are driven by commercial goals and so they are trying to maximize the output and the profits so we will opt for the Output oriented DEA. Further on, taking into accounting the differences in the size of the banks, we will use the Variable to Scale (VRS) DEA modification. And finally, considering the banks as companies who transform the savings into loans, we will use a data set matching the 'intermediary approach'. Thus we will assess the technical efficiency (x-efficiency) of the units analyzed. In economics, x-efficiency is the effectiveness with which a given set of inputs are used to produce outputs. If a firm is producing the maximum output it can, given the resources it employs, such as men and machinery, and the best technology available, it is said to be x-efficient. X-inefficiency occurs when x-efficiency is not achieved. The efficiency score is measured from 0 to 1 (1 represents the most efficient banks).

The sample will encompass data for 23 banks for ten years from 1999 to 2012. The included banks represent around 90% of the total banking assets in the Bulgarian banking system. By excluding the remaining 10% total assets we eliminate from the sample some banks with specific structure and policy (including one state-owned

bank), smaller banks with specific capital structure (including banks with lower than average leverage ratio (assets to equity) and higher Capital Adequacy Ratio), branches of foreign banks (which do not have to comply with the local minimum capital requirements). As we noted before, the DEA model is vulnerable to extreme values, so by eliminating these outliers we are making the sample more homogeneous and thus avoiding unnecessary distortion of the efficiency results.

Each bank from each year will be considered as a separate DMU and will be compared with the performance of the other banks from the same time period as well as its own performance and the performance of the rest of the banks from the other time periods. By this means we can calculate the performance development of the banks in the given time horizon.

As input parameters we use year-end data for: Fixed assets, Deposits, Administrative costs; and for output data: Total loans, Securities.

	min	max	Weighted average DEA score	median	StDev
1999	0.35	1.00	0.712	0.68	0.20
2000	0.36	1.00	0.694	0.68	0.21
2001	0.43	1.00	0.713	0.71	0.16
2002	0.43	1.00	0.736	0.71	0.18
2003	0.35	1.00	0.721	0.68	0.18
2004	0.42	1.00	0.755	0.71	0.19
2005	0.55	1.00	0.802	0.77	0.18
2006	0.40	1.00	0.813	0.70	0.16
2007	0.54	1.00	0.886	0.77	0.12
2008	0.60	1.00	0.892	0.80	0.12
2009	0.64	1.00	0.916	0.82	0.12
2010	0.67	1.00	0.920	0.83	0.11
2011	0.65	1.00	0.931	0.83	0.12
2012	0.65	1.00	0.926	0.83	0.12

*Table 3.1 – DEA scores*

From the results of the model (*Table 3.1*) we can see that efficiency score of the banking system in 1999 was 0.71. In other words the average bank uses only 71% of its inputs (in our case: fixed assets, operating costs and deposits) to produce its

current outputs. By comparison, in 2007 the average efficiency of the banks is 0.87, which means that 87% of inputs are efficiently used.

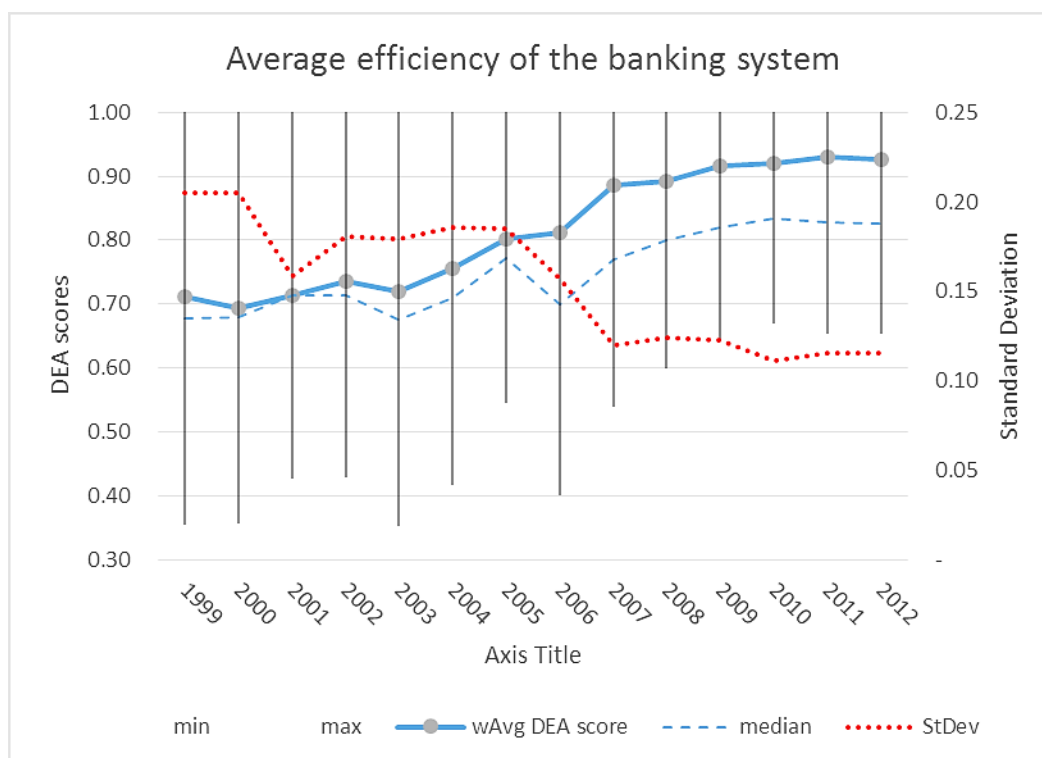


Chart 3.2 – Average efficiency of the banking system

As it could be seen from *Table 3.1* and *Chart 3.2*, there is a large heterogeneity among the banks concerning their levels of efficiency. There is a distinctive trend for increasing the average efficiency of the banking system. Some of the causes for this are the new technologies, knowhow and better administrative cost management implemented by the foreign banks, which further put pressure on the domestic banks and stimulated them to optimize their activities. The temporary slowdown of the trend around 2005 and 2006 is a result of the adoption of measures by the Bulgarian National Bank for slowing the credit boom and of the rise in the interest and related costs of the foreign banks, relying on external financing. In *Table 3.1* and *Chart 3.2* it could also be seen that the variation of the efficiency scores is decreasing (measured by the standard deviation and the difference between the min and max scores) which is a result from the homogenization of the market. Regarding the latter years from

2004 towards 2008 we see that the average efficiency is shifting upwards in the variation band, which could be clearly noted in 2006, 2007 and 2008. This means that the bigger banks are improving their efficiency relatively faster than the others. From 2009 onwards we observe flattening of the trend which could be linked directly to the crisis and the worsening of the real economy conditions.

In order to assess the reliability of the results in *Annex 4* we compare the calculated DEA trend for the Bulgarian banking system with selected accounting ratios showing the efficiency and profitability of the banking system.

### **3.4. Does the privatization play a role in the process of integration towards the European Financial Market?**

In many researches the privatization of foreign state banks is regarded as a form of convergence towards some foreign markets from which the foreign players come. We will try to analyse whether in the case of Bulgaria there is a significant improvement of the banking efficiency due to the entry of the foreign financial institutions, which reorganize and improve the bank processes. To analyze the effect of the privatization processes we are constructing an output oriented DEA model, with input and output data matching the “intermediary approach”. This time the efficiency estimation will be made for each year separately (on cross-sectional basis). By this, we want to eliminate the dependence of a bank performance from its performance in the other years and so to compare clearly the different banks in each period. This also means that we won’t have much change in the scale (the total assets of the banking system), so we will use CRS (constant return to scale) model.

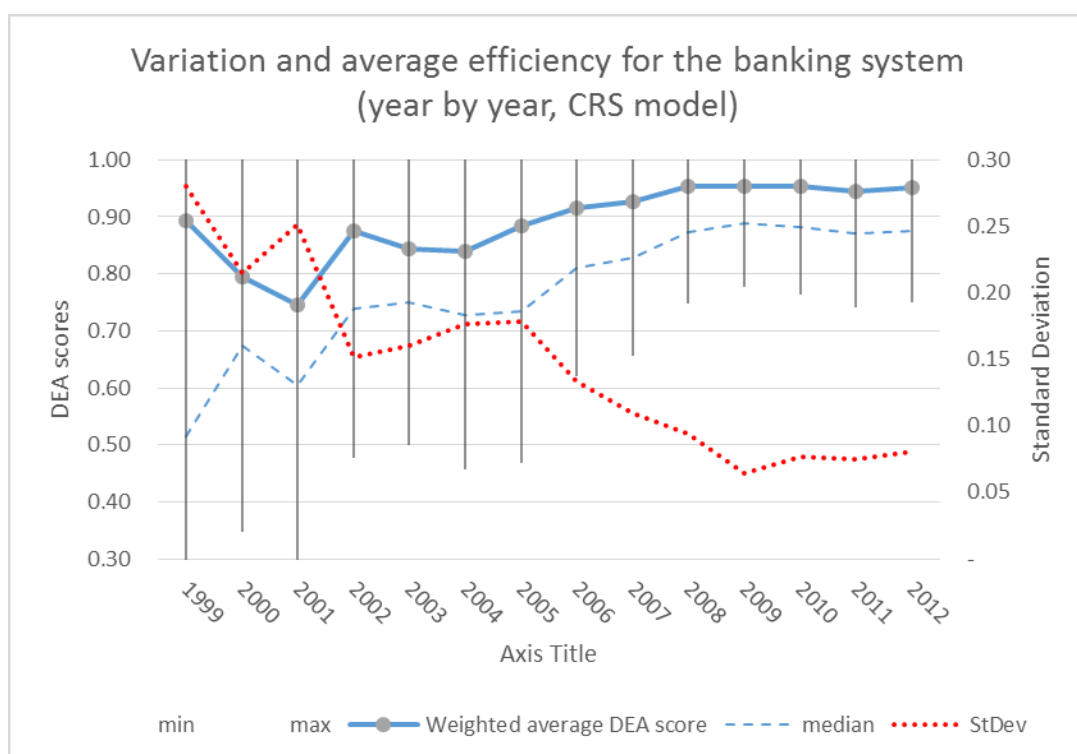


Chart 3.5 – Average efficiency and variation

	min	max	Weighted average DEA score	median	StDev
1999	0.03	1.00	0.894	0.52	0.28
2000	0.35	1.00	0.794	0.67	0.22
2001	0.21	1.00	0.745	0.60	0.25
2002	0.48	1.00	0.875	0.74	0.15
2003	0.50	1.00	0.844	0.75	0.16
2004	0.46	1.00	0.840	0.73	0.18
2005	0.47	1.00	0.884	0.73	0.18
2006	0.62	1.00	0.916	0.81	0.13
2007	0.66	1.00	0.927	0.83	0.11
2008	0.75	1.00	0.955	0.87	0.09
2009	0.78	1.00	0.954	0.89	0.06
2010	0.76	1.00	0.954	0.88	0.08
2011	0.74	1.00	0.944	0.87	0.07
2012	0.75	1.00	0.951	0.87	0.08

Table 3.3 – Average efficiency

The results (Chart 3.5 and Table 3.3) confirm our finding that the heterogeneity in the market is diminishing (i.e. the efficiency scores of the different banks are getting closer – Standard deviation dropping rapidly) and also that the bigger banks are becoming more efficient than the small and mid-sized (the shift in the trend towards the upper side of the band).



By using the DEA model separately for each year we are eliminating the efficiency growth trend in the period and can clearly compare the banks' relative positions.

To find the effect of the privatization we are regrouping the banks in three mutually-excluding groups: Privatized banks, Bulgarian banks, Foreign (green field) banks. Each of these groups has fixed numbers of banks in it. The idea is to assess the change in the efficiency levels of the different groups. The "Bulgarian banks" group consists of banks, which were established by local owners or were bought by Bulgarian investors during the privatization. In the "Privatized banks" group the banks are former foreign owned banks, which were sold to foreign owners mostly during the period 1998 – 2002. Furthermore, the group of the privatized banks includes two Bulgarian banks (one of them not-state owned), which were sold in 2006. This exception is made because the main idea is to analyse the foreign penetration into the banking sectors. The group of the Foreign (green field) banks comprises banks on the local market, founded by foreign investors.

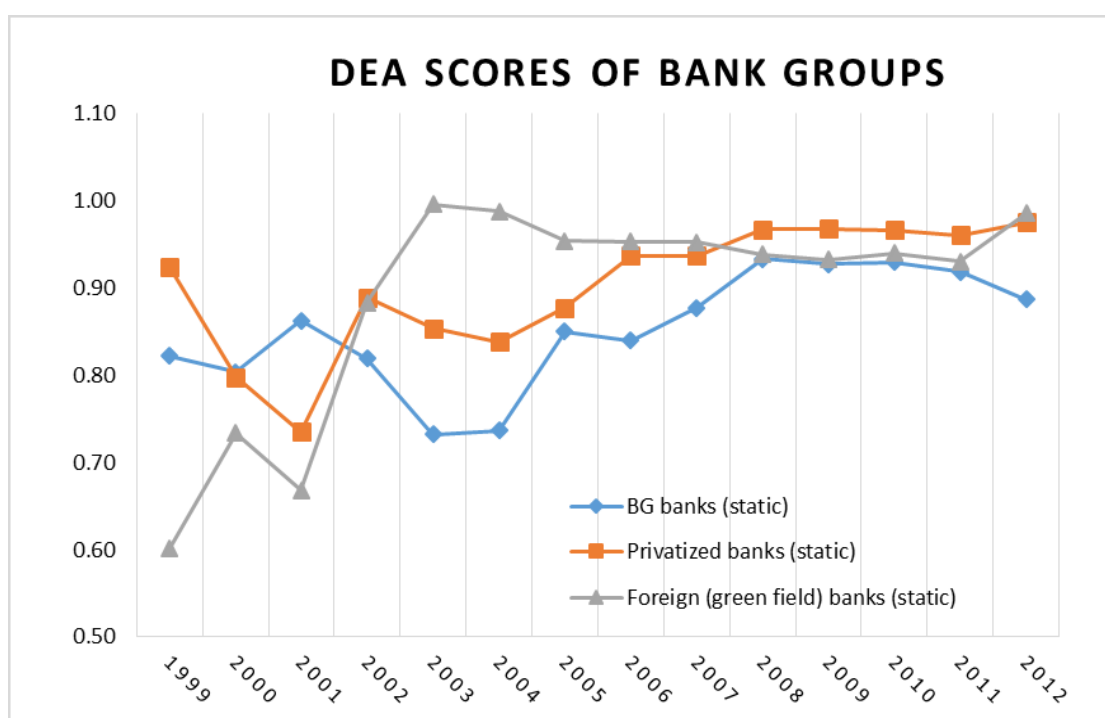


Chart 3.6 – DEA scores by groups

The efficiency scores for the three groups can be seen on *Chart 3.6*. The average efficiency of the Privatized banks is the highest (0.90), followed closely by the foreign (green field) banks (0.89). And the local banks are lagging behind (0.85). Nevertheless the results are very close. At the beginning of the period least efficient have been the green field foreign banks, as they have had limited expertise for the local market, small scale, limited scope of activities and smaller client base. The Bulgarian banks and Privatized (“to be privatized” at that time) have been more efficient due to their past experience and resources. But as the green field banks acquire experience on the market they get ahead of the other two groups, mainly because of the foreign know how, technologies and image. During the years of privatization 1999 – 2003 we can see that the group of the privatized banks also definitively gets ahead of the Bulgarian banks. In this period the foreign owners reorganize the activities and finalize the transition processes, so after 2002 they are permanently more efficient than the Bulgarian banks. In the recent years we can witness that the strong competition has stimulated the Bulgarian banks to optimize their activities so as to keep in pace with the market. Especially in 2007 and 2008 they are closing the efficiency gap between them and foreign (privatized and green field) banks. Also the improvement of the foreign (green field) banks’ efficiency has been more apparent (we should consider that they also have a lower starting base), whereas the efficiency trend of the Bulgarian banks and of the privatized banks is more stable. From 2008 to 2011 the three groups are moving more or less parallel but in 2012 we observe a separation of the trends. The green-field and privatized banks are slightly improving their efficiency while the Bulgarian ones are slightly decreasing in terms of efficiency. This result could probably be attributed to the already stagnated funding market where the Bulgarian banks find resourced more difficult, while the privatized and green-field banks (which are part of larger cross-border groups) have an easy access to funding by their groups and parent banks.

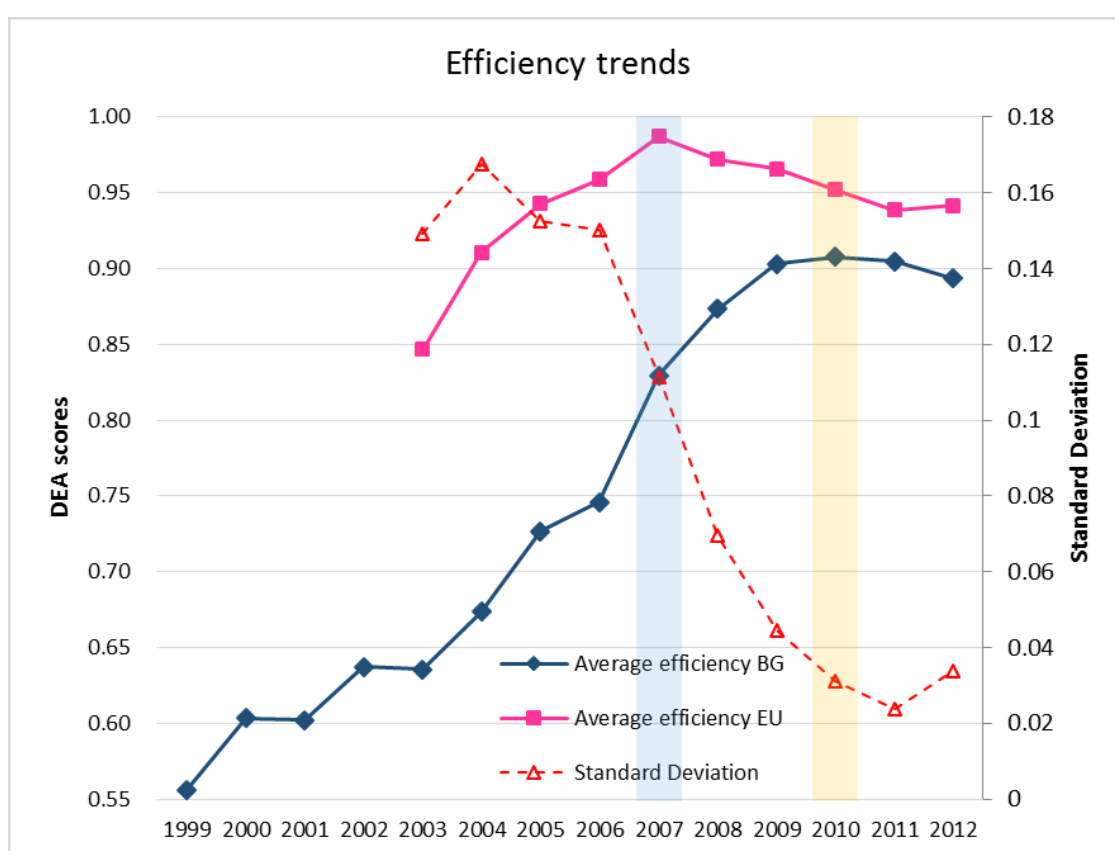
To assess the statistical significance of these results we have conducted a hypothesis testing (*Annex 4*). The results confirm our conclusion, that the

privatization played its role as a form of integration towards the Single European Market. The foreign penetration on the local market has brought new technologies, knowhow and better administrative cost management. Also the access to foreign funds from the parent companies played significant role in the credit boom. All these factors have increased the foreign banks' efficiency which on the other hand had forced the local banks to optimize their operations and as a result we can see an increased efficiency, strong competition and slight market de-concentration.

### 3.5. The Bulgarian banking market: is it getting closer to the European?

In order to reveal the level of integration of the Bulgarian Banking Market towards the European, we will compare the efficiency trends and test for beta and sigma convergence. We are using an output oriented VRS (variable return to scale) DEA model, with input and output data matching the "intermediary approach". To ensure data compatibility we will use the following parameters as inputs: Total Fixed Assets, Total Liabilities and Administrative Costs, and for outputs: Total Net Loans (Total Gross Loans deducted by the Loan Loss Provisions) and Other Earning Assets (securities). The analysis will be conducted with data for 23 Bulgarian banks (around 90% of the total banking assets in the Bulgarian banking system) for the period 1999 to 2012 and 19 of the largest European banking groups (over 50% of the total EU banking market) for the period 2003 - 2012. The data used are on consolidated level. The initial idea was to cover around 90% of the EU market and to use data on solo level. This could have allowed us to compare the average efficiency levels of the different countries in EU and to search also for regional convergence. However, due to some data constraints the scope was lowered to 50% of the EU banking total assets and data on consolidated level. This still enables us to demonstrate the concept without getting into much detail about the efficiency structure of the EU market, assuming it as a peer financial market for the purpose of the comparison.

To examine the simultaneous presence of beta and sigma convergence we will use data for the BG and EU banks together. So the best performing bank in a certain year from the given period will serve as benchmark. Thus we will analyze the development in the efficiency trends, which will help us to search for the presence of beta convergence (the output of the relatively underdeveloped banking systems tends to grow faster than that of the developed ones) and also will help us to see whether the (cross-sectional) dispersion between the performances of the two groups is diminishing, which is a sign for sigma convergence.



*Chart 3.7 – Efficiency trends by groups*

The results show (*Chart 3.7*) clearly that the efficiency of the Bulgarian banks is improving at a higher rate than that of the EU banks. Also the dispersion is diminishing over time. This confirms the presence of the two types of convergence.

Nevertheless we can see that the average efficiency (*Chart 3.7*) of the Bulgarian market is considerably lower than the average EU efficiency. The hypothesis testing confirms these results (*Annex 4*). This can be explained by the fact

that in order to maintain their profitability for a long time the banks on the Bulgarian market could afford maintaining greater margins due to the relatively underdeveloped market and lower saturation. This gave them less stimulus for striving for further optimization of their processes. But because of the growing competition on the local market in the recent years, the banks are improving their performance and in terms of technical efficiency they are catching up to the levels of the European market.

In the pre-crisis years the efficiency of the Bulgarian banks is catching to the European ones, but is still somewhat lower. It is interesting to notice that the trend of the EU banks starts decreasing after 2007 which could be clearly attributed to the recent financial crisis. On the other hand the efficiency of the Bulgarian banks improves till 2010, which is the turning point. At first glance this lag may seem strange, but it confirms the difference in the structures and business strategies between the two groups. The banks in Bulgaria had almost no exposure to such sub-prime instruments. Their business models are mainly traditional ones, focused on corporate and retail deposit taking and lending. Bulgarian wasn't hit by the first wave, but the crisis came through the real economy. The European economy slowdown affected Bulgarian exporters and the Bulgarian economy as a whole. Repaying credit become more difficult and the amount of non-performing loans (NPLs) start rising in the banks' balance sheets, which impacted their efficiency. From 2009 the Bulgarian efficiency trend started slowing down and the turning point is 2010 when the efficiency trend started decreasing.

Looking at the recent years, the EU efficiency score for 2012 is slightly higher than the one from 2011. This is a sign of a slow revival of the lending activities due to demand from the economy or a consequence of the recent ECB long-term refinancing operations (LTROs) from December 2011 and February 2012, which provided low interest rate funding to banks from the Eurozone.

### 3.7. Conclusion from the application of the DEA approach

We use the Data Envelopment Analysis to analyze the level of integration of the Bulgarian banking market towards the European Single Market, by comparing the technical efficiency levels. The DEA has become popular in analyzing different national banking industries. The segmentation of the Bulgarian banking market was made by the criteria for ownership to assess the role of the foreign capital penetration. We have utilized data on Bulgarian banks for the years 1999 through 2012. This is the period for which relatively reliable banks' data are available. To construct the European efficiency frontier we have used consolidated data for 19 banks for the period 2003 – 2012.

In general, the analysis leads to the conclusion that the Bulgarian banking system is consequently improving its average technical efficiency which is mainly due to the stable macroeconomic environment, increased competition and the entering of foreign players on the local market. It is visible that on the one hand the heterogeneity between the market participants is diminishing but on the other, the bigger banks are gaining speed in terms of higher efficiency coefficients.

The banks with significant foreign participation were and are on average more efficient than the domestic ones. The foreign penetration on the local market contributed to these processes with the establishment of new technologies, knowhow, better administrative and cost management and access to foreign funds from the parent companies. All these factors have increased the foreign banks' efficiency which on the other hand has stimulated the local banks to optimize their operations and to be able to keep in pace with the market development. The biggest improvement in terms of efficiency in the given period was experienced by the green-field foreign banks regardless of their initially limited expertise on the local market, small scale and limited portfolio. Because of their foreign know how, technologies and image, they have become the most effective players on the market. The local (Bulgarian and to-be-privatized) banks have been more efficient at the beginning due

to their past experience and resources. After the years of privatization 1999 – 2003 the group of privatized banks also becomes more efficient in comparison with Bulgarian banks due to the reorganization of their activities and access to the group resources. In the recent years we are witnessing that the local banks are already closing the efficiency gap.

Upon comparing the performance of the Bulgarian market with that of the European market, we can conclude that the difference in the technical efficiency levels remains substantial, which supposes that the locally presented banks are utilizing their resources less optimally than the European ones. However, we can note that a clear trend of integration is in place, confirmed by the presence of beta and sigma convergence in the average efficiency levels.

Further evidence for the remaining heterogeneity in the characteristics between the banking markets of different EU Member States is their different reaction to the recent crisis in terms of changes in their efficiency scores.

Research in this area shows the possibility to use innovative ways to analyze the structures that influence operational decisions.

## **Chapter IV - THE NEED FOR TRANSFORMATION OF THE GLOBAL FINANCIAL SYSTEM AND FINANCIAL INSTITUTIONS. INNOVATIVE APPROACHES FOR IMPROVING THE FINANCIAL STABILITY OF THE SINGLE EUROPEAN FINANCIAL MARKET IN THE GLOBAL CRISIS - NETWORK-CENTRIC MODEL OF THE BANKING SYSTEM**

The recent global experience highlights the need to monitor systemic risks arising from both the macroeconomic developments in the economy and from the global financial markets. Integration of economies and modern technology opens up new challenges to the global stability. This requires new concepts, methodologies and models for financial system transformation and network crisis management.

The network approach can be an effective tool for solving problems posed by the global crisis. It is associated with the introduction of the paradigm of security and stability in the financial system, including key elements such as bodies for banking and financial supervision and regulation. A paradigm is seen as a key model or method for achieving certain type of goals. The aim is to achieve effective organizational and operational transformation. This transformation offers new opportunities for prevention based on new approaches for ensuring sustainability and viability of Single European Financial System in times of crisis.

Using the theory of networks, one can improve the functioning of the financial systems. The application of Network approach to the financial systems is especially important in assessing the financial stability. For example, the resilience of a banking system to shocks can be evaluated according to the network structure that connects the financial institutions.

The adopted framework introduces: surveillance at macro-level (surveillance on financial stability), through the creation of the European Systemic Risk Board in the European Central Bank, and supervision at micro-level, implemented by the European System of Financial Supervisors.



We propose the adoption of the banking system as a separate critical infrastructure and the inclusion of the banking and financial supervisory authorities as key elements in a decentralized network for financial regulation on a supranational level. The goal is to coordinate and facilitate the work of national supervisors and to synchronize financial regulation and supervisory practices that are the basis for the integration of financial markets.

The need for transformation of the financial institutions during the current crisis requires seeking and implementing new approaches for ensuring stability and efficiency of the financial system.

The purpose is to describe the need for enhanced transformation of supervision and regulation of the banking system of the European Union, but also to show the possibility of achieving a decisive efficiency and stability through the introduction of concepts related to the network approach and treating the system as a critical infrastructure. On the basis of means related to the construction of high operational safety systems it is possible to outline ways to transform the financial (banking) system, from a structure with subsequent (delayed) regulation and management, into an operational self-regulating system (system of systems) operating in near real-time. This transformation would allow sharp increase in stability and operability of the system.

The issue about the structure of the supervisory process is always escalated during crises moreover this is the time when most of the reallocation of supervisory responsibilities is carried out at an institutional level. At this stage, in contrast to previous financial crises, the discussion has a global nature. Coordination at international level rises as a priority as internationally active financial institutions (mainly banks) have a global reach with their subsidiaries and international branch network.

The development of supervisory processes at European level is directly related to the priorities for development of the European single financial market placed in

1999. The financial crisis forced a reconsideration of the structure of financial supervision and regulation, and boosts their improvement initiatives. Leaders of the G-20 meeting in Mexico agreed on the need to transform the financial institutions and in particular for increased regulation of the financial system. EU leaders expressed their satisfaction that the group of 20 has confirmed its commitment to "fully and quickly place a financial reform to build a strong and responsible international financial sector". This transformation will open up new opportunities for prevention and will ensure sustainability and viability of the system of financial institutions. In this respect the possibility to search and implement new approaches to ensure stability and efficiency of this system is presented. Such a possibility could occur with the use of innovative tools from the scope of network-centric systems, typical of the area of national and international security.

The experience from the current financial crisis highlights the need to monitor systemic risks arising from both the macroeconomic developments in the economy and from the global financial markets. Integration of economies and modern technology opens up new challenges to the global security. This requires new concepts, methodologies and models for transformation of the financial system and network crisis management.

#### **4.1. The need for transformation of the financial system**

A number of papers of the European Commission (EC, 2012), (COM (2012) 511 final) (EC, 2012) etc. underline the need to bring up to date the financial sector through the establishment of a European Banking Union. The political vision for further EU integration based on the latest important measures for tighter regulation of the banking sector, has also been stated in the said papers.

The general framework of the EU for instruments for recovery and resolution of the banks offers in the first place means to prevent emerging crises and to deal

with them in the early stages. These instruments will be proposed to the banking sector by the European Stability Mechanism (ESM).

At the summit in June 2012 the European Union agreed to create a new centralized European banking supervisor (step towards establishing a European Banking Union) to supervise and recapitalize banks in Europe. It will provide direct assistance to banks, not through the governments, so as to not further increase the national ineptness. Thus creating goals and a new management framework, providing national supervisors additional powers for closer monitoring of banks, and to take any restrictive-up of risks.

In connection with the above, measures have been prescribed in the medium term to introduce a more integrated and immediate banking supervision at the EU level and a common deposit guarantee fund for recovery of banks, where these measures have been based on the political guidelines of the European Union.

The following elements of the general framework are of major importance:

- **integrated system of supervision of cross-border banks**, overcoming the existing fragmentation of the supervision;
- **a unified deposit guarantee scheme**, combined with the recovery fund into a single general framework;
- **EU resolution fund for resolving troubled banks.**

The idea that the European Financial Stability Mechanism may provide aid to banks is also promising.

The European Commission envisages the setting out of a common framework of rules which will help Member States and national regulatory authorities to take fast and effective action to deal with the banking crisis, such as:

- **give public authorities greater powers** in order to prevent bank failures;
- **make it obligatory for all major banks to have a recovery plan;**

- **ensure early intervention**, when the capital reserves of a given bank fall below a certain level and the bank must carry out major reforms to restructure its debt, if necessary;

- **allow national authorities to take control** over a failing bank;

- **ensure a more effective cooperation between national authorities** with respect to the support for a cross-border bank experiencing difficulties - in such cases the European Banking Authority will play a major role.

From the above it follows that it is appropriate to:

1. Provide in a timely manner (near real time) the centralized European Banking Supervision with current operational information on bank restructurings and recapitalization needs.

2. Provide opportunity for the centralized European Banking Supervision to realize the network performance of its functions in response to the dynamically changing network structure of the supervised interdependent banks.

For the realization of these opportunities we propose:

1. The inclusion of the banking structure in a suitable **simulation model** which should provide supervisory authorities and bank managements with the necessary information on possible failures (collapse) in the system.

2. The realization of the centralized European banking supervision as an **influence network** ensuring the operability of the entire banking system based on shared information.

3. Integrating the simulation structure and the influence network into a **network-centric architecture**, ensuring the operability and stability of the banking critical infrastructure.

The overall objective is to achieve greater **financial stability**.

In order to perform the specific tasks presented here and to achieve effective transformation of the financial sector in the EU it is appropriate to analyze the nature of the financial and banking system in terms of:

- Network architecture;
- Critical interdependent infrastructure;
- Complex adaptive system.

These characteristics of the financial system could allow, through the application of innovative approaches and tools, its building up as a network-centric multi-agent architecture.

The realization of this opportunity would secure high operability and stability of the financial system. For this purpose, we examine the appropriate innovative approaches and tools, and their ability to model and analyze the complex financial system.

#### **4.2. The network approach and paradigm on security and stability of the financial system**

A possible new approach for resolving the fundamental problems, connected with the global crisis, is the implementation of paradigm for security and stability of the financial system, including the financial regulatory and supervisory authorities as key role players.

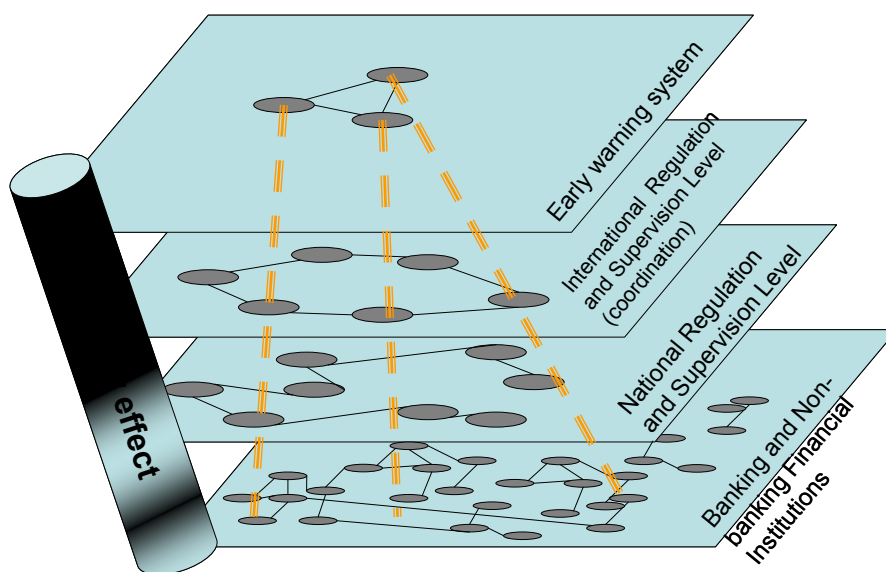
We see this paradigm as a key model, standard or method (for achieving certain goals). The aim is an effective organizational and functional transformation. This transformation gives new opportunities for prevention, based on early warning systems, as well as quicker seizure of financial contagion, and ensuring a stable and viable system of financial institutions in case of partial system disintegration (when some part of the system is not functional any more – defaults, systemic risk, etc).

There is an increasing consensus in the economic literature to recognize that network structures significantly influence the outcomes of many social and economic activities. The use of network theories can enrich our understanding of financial systems. We review the recent developments in financial networks, highlighting the synergies created from applying network theory to answer financial questions. A network approach to financial systems is particularly important for assessing financial stability. For instance, the resilience of a banking system to contagion can be evaluated depending on the network structure that connects financial institutions.

The main goal is to make effective organizational and functional transformation, so the system could achieve greater sustainability and efficiency. Such a possibility seems to be the adoption of the banking system as a separate critical infrastructure (Mirchev, 2009) and the inclusion of banking and financial supervisors as key elements in a self-synchronizing network for financial supervision and regulation at a supranational level. The critical infrastructure in this area is important to national and international security and the efficiency and accuracy of decisions in critical situations are crucial for the stability of the financial system.

The goal is to coordinate and facilitate the work of national supervisors and to synchronize financial regulation and supervisory practices that are the basis for the integration of financial markets.

This system is actually a system of systems. The advantage of such network structures with decentralized management is that they are more resistant to crisis situations and to disruption of their integrity. Based on this concept we can outline a four-layer network architecture for financial supervision and crisis management.



*Chart 4.1 - Four-layer network model for financial supervision and crisis management*

The network approach presumes the development of concepts, methods, practices and new organizational structures for financial processes transformation and in particular for improved regulation of the financial industry. A network, linking the hierarchically or geographically spread organizational structures, provides opportunity for exchange of operational information, cooperation, and establishes a centralized shared awareness. This in turn leads to synchronization of the system as a whole. The result is increased efficiency, improved resistance to destructive influences and viability in crisis situations.

The need of network implementations in the financial domain arises from the Memorandum of understanding on cross-border financial stability, signed in June 2008 by the financial supervisory institutions, central banks and finance ministers from the EU, and from the general practical guidelines for crisis management.

The recommendations set forth in these documents create opportunities for the application of network approach for transformation of the financial system. Through ESRB, the ECB will have access to supervisory information at micro-level. With the implementation of a modern model of a network for crisis management and

with the cooperation at the international level, effective mechanisms for resolution of crisis situations could be created. Information will be exchanged in real time and will provide relevant data for decision making in crisis situations.

The European regulatory bodies - the European Systemic Risk Board and the European System of Financial Supervisors are network elements at the EU level. The inclusion of these structures and the banking system in a single framework form complex multilayer system, ie network of networks. This system is actually a system of systems. Based on this concept we can be outline four layer network architecture for financial supervision and crisis management (*Chart. 4.1*).

Institutional development of the supervisory architecture in the European Union (a relatively short period of time) with models "Lamfalussy", "Larosiére" and the introduction of a Single supervisory mechanism outlined the importance of supervisory processes for solving problems of the EU Single financial market.

Complex multilayer structures, shown in Chart 4.1, as well as very large dimensions make the operational functioning of the system difficult.

In the methodological prerequisites for the introduction of innovative tools - basic requirement is to reduce the number of organizational levels, creating a direct link to the source of information and increase the pace of operational performance. For this purpose, we present ideas for network approach and two-layer network-centric architecture as prerequisites for achieving supervision and regulation in network-centric environment for the transformation of the banking system of the European Union (Mirchev, 2012).

We propose the inclusion and development of these opportunities as necessary basic elements of a common network model for transformation, stability and efficiency of the financial system.



### **4.3. Models and practices for the identification, designation and protection of critical banking and financial infrastructures**

Protection of critical infrastructure is widely used in control theory, economics, and especially in research on security issues. The term "infrastructure" was originally introduced in the military over the past century, but gradually its orientation is mainly to systems of national and international security (Хаджитодоров, 2007).

#### **U.S. experience**

First we will study the U.S. experience in the financial field in light of its rather direct engagement with problems of the overall system of security and stability. The U.S. Department of the Treasury and several other agencies make efforts to ensure the financial stability of the economy upon destructive physical and economic impact (Weiss, 2009). The regulatory bodies in the financial sector have developed regulations to overcome the physical and economic shocks. Many of the measures to protect the financial institutions against attacks are part of a broader national security effort in the United States (Weiss, 2005).

As stated in the aforementioned sources, the financial institutions, including banks and other depositories, securities dealers, insurance and investment companies, are a part of the critical structure of the country.

Financial institutions face two categories of emergencies that could impair their functioning.

The first is directly financial: a sudden drop in the value of financial assets, whether originating domestically or elsewhere in the world, that could cause a national or even global financial crisis.

The second is operational: the failure of the support structures that underlie the financial system. Either could disrupt the nation's ability to supply goods and services. They could reduce the pace of economic activity, or at an extreme, cause an actual contraction of economic activity. Regulators generally address financial

problems through deposit insurance and other sources of liquidity (such as emergency loans) for distressed institutions, through safety and soundness regulation, and via direct intervention. One approach is to create special purpose responses to financial stress, such as the Troubled Asset Relief Program (TARP) and Term Asset-Backed Securities Loan Fund (TALF). These approaches relate to the remedial effects against operational risks through corrective actions, redundancy, regulation, auditing, and other physical security. Under the worst case scenarios, the Federal Reserve (Fed) attempts to limit economic damage by supplying liquidity to the financial system and employing monetary policy to expand domestic demand (as it did following the 2001 terrorist attacks). In the Terrorism Risk Insurance Act of 2002 (TRIA), Congress expanded the Fed's ability to act as lender of last resort to the financial and real economies (Weiss, 2009).

In connection with the foregoing, it should be noted that U.S. experts (Moteff, 2004) point to financial services as a critical and financial information structure and banks and finance as a critical structure of a general nature.

In relation to the number of documents (Moteff, 2004) in the United States is prepared National Banking and Finance Sector specific plan - SSP (DoHS, 2007), which is part of the overall National Infrastructure Protection Plan (NIPP). The NIPP provides the structure for integration of this SSP and the SSPs of the other 16 critical infrastructures and key resources. To achieve this interaction one relies on public-private partnership under which programs are developed for protection and crisis management, as well as sector-specific plan (SSP), which provides the Banking and Finance Sector's strategy. This sector plan has been prepared in close collaboration with the Financial Banking Information Infrastructure Committee, (the Financial and Banking Information Infrastructure Committee - FBIIIC).

The study of the U.S. experience presented above sector is directly related to the establishment of the Single European Banking Supervisors. Future features of this

surveillance can be supported by the authorities to protect European critical infrastructure.

Essential for banking and financial sector is the structure of federal and state regulators and self-regulatory organizations. Financial regulators work through FBIIC, to coordinate efforts to address critical issues for infrastructure protection. Private sector pillar of security (DoHS, 2007) is organized by the financial sector of the Financial Services Sector Coordinating Council for Critical Infrastructure Protection and Homeland Security - FSSCC. This organization includes the Financial Services Information Sharing and Analysis Center - FS-ISAC with regional coalitions. With direct assistance FBIIC financial regulators assess the banking and financial sector, identifying strengths and weaknesses in the domestic financial system, and also determine which institutions play an important role in the systematic sector.

Despite initial activity in implementing the Action Plan for Critical structure of the banking and financial sector in the U.S. - (DoHS, 2007) in the summer of 2007 financial crisis unfolded, starting from a small part of the U.S. market for high-risk mortgages. The described model for the protection of critical structure sector "Banking and Finance" in the U.S. has hardly been able to account for the network nature of the spread of the crisis. So the crisis spread, affecting other markets around the world and caused extremely social harm.

### **Experience in the European Union**

The EU policy on critical infrastructure protection (CIP) is coordinated by the Directorate General "Justice, freedom and security" of the European Commission. In 2005, a special "Green Paper on a European Programme for Critical Infrastructure Protection" was published, containing a recommended list of sectors of the critical infrastructure. The authors of this paper also offer definitions of the terms "national critical infrastructure" and "European critical infrastructure."

On the basis of this Green Paper, in 2006 was launched the European Program for Critical Infrastructure Protection (EPCIP).

A following EU document was the Proposal for a Council Directive of 2006 on the identification and protection of European critical infrastructure and the assessment of the need to improve the protection of such infrastructure.

This document defines basic terms like "vulnerability", "risk", "threat" and contains a recommended list of sectors of the critical infrastructure. One of these sectors is "Financial sphere". This list is subject to update. The national specifics may modify the scope of the term "critical infrastructure" in the respective legislation, but the review of models and practices for critical infrastructures protection in several leading countries in the EU and elsewhere shows that the sector "Banking and Finance" is invariably present in the lists of sectors designated as critical infrastructure.

Upon implementation of the EPCIP the EU member states are required to develop a respective National program for critical infrastructure protection. The review and analysis of these programs show that the sector lists and the relevant EU legislation concern actions to protect mainly technical structures in the event of disasters.

Considering the financial structures as an element of the critical infrastructure, according to the Opinion of the European Central Bank of 13 April 2007 on a proposal for Council directive on the identification and designation of European Critical Infrastructure and the assessment of the need to improve their protection (ECB, 2007), allows the application of network systems methodology with all their opportunities to achieve viability, stability and efficiency of operation and prevention, preparedness and response to threats involving critical infrastructures and interdependencies between sectors.

The proposed Directive (ECB, 2007) establishes the procedure for identification and designation of European critical infrastructures, disruption or destruction of which would significantly affect two or more Member States or one Member State if the critical infrastructure is located in another Member State.

The ECB has concluded that particular attention in this regard should be given of the operation and supervision of infrastructure and systems for clearing and settlement of payments and securities by the central banks of the European System of Central Banks (ESCB) and the contribution of central banks to the stability of the financial system.

In the legislative Resolution of the European Parliament on April 22, 2009 on the proposal for a Council decision for Critical Infrastructure Warning Information Network (CIWIN) (European Parliament, 2010) is recorded that: The Council supported the Commission's plan to propose a European Program for Critical Infrastructure Protection (EPCIP) and approved the establishment of CIWIN by the Commission. This Decision establishes a secure system of information and communications - Critical Infrastructure Warning Information Network (CIWIN) to assist Member States to exchange information on vulnerabilities and appropriate measures and strategies to reduce risks associated with the critical infrastructure protection (CIP).

The legislative Resolution of the European Parliament on April 22, 2009 gives a contemporary definition of a "Critical infrastructure": those assets, systems or parts thereof located in Member States which are essential for the maintenance of vital societal functions, health, safety, security, supply chain, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions.

The analysis of the current state of protection of the financial critical infrastructure shows that the protection is activated only when it is necessary to reinforce the measures for protection. This protection is not systemic in nature and there is no integrated effect of its interaction within the EU. It relies heavily on organizational activities, and the necessary information for timely and appropriate response to the new threats is still not being provided.

The guidelines for solving this problem are related to the opportunity to build effective protection for the financial critical infrastructure within the EU, so as to create conditions for a sharp increase in its stability and operability. The implementation of a network-centric approach is one of the latest opportunities in this area.

The efficiency of a network structure is much greater than the sum of the individual efficiencies of its elements, which is provided by the synchronization and synergy between the activities of these elements achieved through information sharing in a network-centric environment. This provision is one of the most effective approaches as it does not require significant additional costs and resources. Moreover, reducing the risk for the financial critical infrastructure to the desired level is possible without radically changing the basic principles for structuring the system managing this infrastructure. Such "network" concept allows the formulation of requirements for new capabilities of the financial system with a constant awareness of the situation in all its aspects.

### **Legal basis in Bulgaria**

The term "critical infrastructure" appeared in the Bulgarian legislation in 2005 with the adoption of the Crisis Management Act. Under this Act, the Council of Ministers adopts the National Programme and the Annual National Plan for Critical Infrastructure Protection.

In the process of planning the policies and activities for protection of the critical infrastructure of special importance is the creation of a legal framework for the realizations of efficient public-private partnerships. The U.S. experience in this regard is quite indicative. Most of the components of the critical infrastructure, including banking institutions, are now privately owned. Therefore, their protection can only be achieved in close cooperation with their owners and operators.

The Decree of the Council of Ministers of the Republic of Bulgaria No. 18 (Council of Ministers, 2011) identifies and designates European critical infrastructures

in Bulgaria and sets measures for their protection. A potential European Critical Infrastructure (ECI) is designated as such after agreement with Member States that may be significantly affected. The above decree stipulates the procedure for the identification and designation of ECI located on the territory of Bulgaria and the measures for their protection in the energy and transport sectors. Decree No. 181 of the Council of Ministers of 20.07.2009 identifies objects and activities that are important for national security and are part of the critical infrastructure. The list appended to this Decree contains the following strategic activities for sector "Finance":

- Payment services;
- Banking and insurance services.

These activities for the "Finance" sector are mostly of technological nature. Directive 2008/114/EC (Council, 2008) on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection states that the Directive is the first step in a phased approach for the identification and designation of ECI and the respective actions for their protection. In light of all this and of the possibility to overcome crisis events in the banking sector – we propose regarding the banking system as a separate, but basic critical infrastructure, affecting all other sectors of public activity.

### **The concept of banking critical infrastructure in a global crisis**

Given the vulnerability of the banking system, we propose the application of the concept of critical infrastructure so as to ensure better protection of the interests of the whole society. We define the banking system as a separate, high-level "economic infrastructure", given its important role in the modern economy.

The need for determining the criticality of a given object and/or infrastructure often comes post-factum, i.e. after the disturbance of the functioning of the object or system (infrastructure) has occurred. In order to overcome this undesirable effect, it is advisable to improve the understanding of criticality. In practice, the *systemic*

*concept* for understanding the criticality prevails (Tagarev and Pavlov, 2005). This approach assumes that an infrastructure or its components are critical due to their structural position in the overall system of infrastructures, especially when it comes to important links with other sectors or infrastructures. The systemic approach focuses on the interdependence between infrastructures and their components.

The systemic concept for understanding the criticality is directly related to issues of national and international security.

The other approach – the symbolic concept (Tagarev and Pavlov, 2005) for understanding the criticality – regards the interdependence as having secondary importance; here the symbolic significance of an infrastructure for the society is of primary importance.

For the purpose of this study it is useful to apply suitable methods for analyzing the critical infrastructure and supporting the development of measures for its protection. More typical opportunities are provided by: modeling networks and means of protection; methods and tools for analysis of complex adaptive systems; agent-based modeling; expert evaluation and simulation.

The concept of critical infrastructure protection allows the construction of fundamentally new types of models to ensure stability and operability. For a better protection of the banking system in this context we further propose (in combination with innovative approaches) a framework model to strengthen the stability of the banking sector based on greater operability and security.

#### **4.4. Framework model for building the Single European banking market as part of the Security system (critical infrastructure)**

At EU level, stock exchanges and settlement systems have been deemed critical infrastructures. Considering the importance of the banking market (which dominates over other sectors of the financial market in the EU), **we suggest its consideration as a separate critical infrastructure** (economic network infrastructure).



Unlike those critical infrastructures (stock exchanges and settlement systems) which are mainly technical infrastructures, the banking market is a higher level infrastructure, playing an important role in the development of all sectors in the economy. It operates using technical infrastructures, such as: payment systems, information systems, etc., building on them through the application of economic models and providing financial services to bank customers, thus turning itself into a financial infrastructure – a tool for business conduct.

The protection of this critical infrastructure would allow the construction of a fundamentally new type of model for ensuring stability and efficiency of the banking market. So the strategy for preserving and strengthening the financial stability will exceed national boundaries. This will allow a more flexible approach than the currently adopted, which is based on voluntary co-ordination between national supervisors and has not been sufficiently effective.

A model for analyzing and strengthening the stability of the banking market, considered as critical infrastructure, would include the following steps:

- (1) Mapping the real topography (the banks' inter-connectivity) of the banking network.
- (2) Identification of the hubs in the system – the supervisory efforts could be focused on these nodes depending on their importance.
- (3) Assessing the extent of the threat / possible damage, which a hub brings to the system. The risk depends on the hub's size and connectivity with other hubs and nodes in the network. This evaluation is performed through simulations or analysis of the development of a "fault-tree" for spreading the initial shock.
- (4) Budget analysis – determines the optimum allocation of resources. One possible tool is the "network-wide investment" – after assessing the possible negative effects of each hub in the system, the investments are allocated in

such a way that minimizes the overall negative effect. Priority is given to the most important hubs, which have the greatest impact on the network stability.

For applying such model there could be implemented and refined a few basic principles (Lewis, 2006), to which we add specific interpretation for the area of banking systems:

*Principle 1:* You need a network to fight a network. Applied to the banking system, this principle may have the following two meanings:

(1) The systemic instability in the banking market has a network character, so the means to oppose it should also have a network character. It also suggests a new type of network supervision with new organization of the supervisory processes depending on the topology of the banking system.

(2) Due to the size of the European and the international banking market only the network approach would be effective. It is not economically feasible to protect every link in the system. European Commission studies show that the national Deposit Guarantee Schemes in the EU would not withstand the shock if several hubs (large, systemically important banks) fail.

*Principle 2:* Protect the hubs, not the connections. This principle is directly related to the preceding because the banking market is built on a network basis. Hubs are critical points, therefore they must be protected. Considering the scarcity of resources and the fact that such a network could be enormous in size, it is not possible to protect each node of the system, so efforts should be focused on the critical points.

*Principle 3:* Invest 80/20. The capital in the banking system is not equally allocated. One could say that the majority of the assets in the banking system are held by a small number of banks. This suggests that the 80/20 rule could be applied, i.e. 80% of resources should be invested in 20% of the units (which are critical to the system).

*Principle 4: Asymmetric thinking.* Innovation in the financial sector often is used as a way to avoid certain regulations. In this regard, regulatory approaches must evolve, and adapt to the market situation, and anticipate and manage the development of the system.

*Principle 5: Dual purpose solutions.* The scarcity of government resources raises the question of the stakeholders' involvement in the process of seeking solutions for improving the stability of the banking system. For example, the establishment of joint entities for electronic or cash payments, the creation of buffer funds and other initiatives with purely private capital, would increase the stability of the system, but would also help to improve its efficiency. Thus resources optimization could be achieved.

#### **4.5. Innovative approaches and methods for the formation of a conceptual model of the banking system as a critical infrastructure**

In accordance with the definition of critical infrastructure (European Parliament, 2010) we regard the banking system as a component of the system of interdependent critical infrastructures shaping the national and international security. In this regard, the study of infrastructural interdependencies is essential. The critical infrastructures (CI) can be modeled as self-organizing complex networks (Issacharoff et al., 2006).

Over the past two decades the studies on complex dynamic systems have greatly increased (Goldenfeld & Kadanoff, 1999; Oltvai & Barabasi, 2002), including the studies on banking networks as such dynamic systems (May et al., 2008). Further studies on the need for regulatory reform have pointed out the necessity to apply innovative approaches in order to reduce systemic risk. In particular, Haldane (2009) regards the financial system as a complex adaptive system (CAS).

The study of infrastructural interdependencies, combined with simulation modeling, is a relatively new field.

Below we present the main innovative approaches and methods, and specific implementations of complex adaptive systems, enabling the development of a conceptual model of the banking system operating as a critical infrastructure. The scope of these innovative tools includes also the simulation modeling capabilities of research and analysis of strategies for protection of the banking sector in crisis situations.

Another possibility for simulation of failures in networks and in interconnected systems is provided by the Petri Nets (Mirchev & Filipova, 2009) as a formal method for modeling and analysis – Annex 5 of the dissertation. A conclusion is derived for the possibility to include such an analysis in a general model of a Network approach to implementing transformation and ensuring the stability and effectiveness of the financial and banking system.

#### **4.5.1. Network-centric approach**

The network-centric concept is based on the experiences of organizations and economic sectors that have successfully adapted to the challenges of the information age. This concept is applicable to network-structured organizations. A feature of systems built on network-centric concept is distributed (decentralized) decision making responsibilities in critical situations. Based on the shared common operational information field, decisions in critical situations are taken close to real time.

The vision of network-centric enterprise (Alberts et al., 2000) is associated with awareness and appropriate information management, creating opportunity for self-synchronization. As a result of this type of management is the achievement of increased efficiency (pace) and responsibilities, reducing risk and costs and achieving higher results (profits). Results are due in large part to the opportunities for virtual organization, cooperation and integration in network-centric environment.

The network-centric concept is based on the principle of self-synchronization specific to the theory of complex systems. The essence is that complex phenomena and structures are best organized bottom-up. It is necessary that this process stays within the accepted standards and regulatory requirements in the financial sector.

Achieving greater efficiency in network-centric organization can be key in solving the "Financial trilemma" (Schoenmaker, 2011). The problem is raised by Vitor Constancio - Vice President of the ECB (Constancio, 2012) in relation to the need for a European Banking Union. The trilemma illustrates the inability to simultaneously achieve three important objectives in an environment of global financial markets.

These objectives are: financial stability, financial integration and maintenance of national financial policies. The logic is that with increasing financial integration, the pursuit of national financial policies will not lead to financial stability. National policies aim to ensuring national prosperity without taking into account external supervisory practices of other countries (Holthausen, Ronde, 2004). This leads to a lack of financial stability as a public good (Beck et al., 2010). The problem is exacerbated by the fact that the measures taken are implemented slowly, leading to the accumulation of negative results.

The proposed by the European Commission new unified organization for banking supervision, a new pan-European deposit insurance and a European framework for restructuring and reorganization of institutions can be effective only at high operability, eliminating the effects of the trilemma.

The nature of the network-centric approach is the ability to exchange information in the composition of the so-called "influence networks". This is essential for achieving shared awareness in the executive departments as an opportunity for cooperation and synchronization. The influence network theory has numerous and significant applications. This theory is based on the theory of stability (Lewis, 2009).

Based on the new information technologies it is possible for the information from the network structure of interdependent supervised banks to be combined with

the information coming from the Single Supervisory Mechanism. This would achieve the full awareness and necessary networking capabilities of the system, including ensuring interoperability.

Setting new requirements for the financial system in the EU in relation to new structures and new relationships, especially those for adapting the existing Regulation of the European Banking Authority to the new regime for banking supervision leads to upgrade of the hierarchical system but also to increase of its complexity. We must add the fact that the Single Supervisory Mechanism (in ECB) will monitor about 6,000 banks in the euro area. Creating a new strong centralization of the management structure, headed by the ECB is likely to result in delayed reactions through the hierarchical administrative structure, respectively, downstream regulation-supervision. To avoid these undesirable effects is appropriate to introduce a modern approach and means to achieve interoperability (speed, pace) in the financial system.

In the existing European banking architecture the influence network is formed by autonomous agents - the European Systemic Risk Board and the European and national supervisory authorities. Interdependencies between the agents in the influence network determine the relationships between the agents from the second level (the banking network). The relationships in the influence network form a vision for the magnitude of the risk, the necessary regulations, capital adequacy etc.

The perspective network-centric organization of influence network regulation and supervision shows the possibilities for dissemination of information on banking transactions on a daily basis, while forming the so-called common awareness. So far, this technology has been introduced only for the participants of the stock market. The opportunity stems from the fact that each bank calculates their balance parameters every day. Practically this allows the supervision and regulation to be performed near real time, which transforms the banking system, ensuring its high efficiency. Furthermore the decision making process is dynamic, i.e. depending on the

size and location of existing problems, different centers of decision-making are formed. In the current system (hierarchical structure) most of the important decisions must be coordinated with the European supervisory institutions. There are certain procedures requiring considerable time, including for appeal. The system is far outside the desired efficiency.

#### **4.5.2. Multi-agent modeling of critical infrastructures in the financial system**

A relatively new option is the application of Multi-agent modeling in critical infrastructures with Network-centric approach to implementing multi-agent simulation of critical infrastructures, combined with the use of network-centric approach. Cascading effect is a major source of vulnerabilities in critical infrastructure systems. The domino effect is a major source of vulnerabilities in critical infrastructure systems. There is a view that agent-based simulations arise as the most promising technology for modeling infrastructure systems, aiming for anticipate, manage and optimize them.

Agent-based modeling is a powerful simulation modeling technique that has seen a number of applications in the last few years, including applications to real-world business problems. Agent-based simulations (ABS) are applicable to problems that can hardly be solved by traditional analytical tools, because these problems can hardly be described and / or treated mathematically. ABS provides a method for analyzing the possibility of infrastructure interdependencies through multiple agents (software systems) and environment to simulate the processes of decision-making agents. Agent in the simulation, according to some definitions, is a software implementation of the unit, taking decisions with agent-based models (ABM). The Agents may be special objects of software engineering, possessing a certain degree and intellectual identity.

One new goal is modeling with an emphasis on analyzing the impact of dependencies between interacting heterogeneous infrastructures. There is agent-based approach that uses behavioral modeling of such infrastructures to identify vulnerabilities (Tolone, 2008). A multidimensional approach (Cougaar, 2012) is used to study the relationship between the layers of critical infrastructure.

We present more characteristic information for specific implementations confirming innovation and perspective application in the financial district of complex decentralized systems with multiple interacting autonomous decision nodes, or agents:

## 1. MULTILAYER MODEL OF FINANCIAL STABILITY

A development of the above-mentioned approach is the drafting of a Multilayer Model of Financial Stability by exploring the integration of system dynamics and agent-based models (Martinez-Moyano et al., 2007). In this case financial infrastructure modeling is the domain problem that motivated the integration of different levels of aggregation in models of complex systems. In a project called the Critical Infrastructure Protection Decision Support System (CIP/DSS), researchers model different critical infrastructures and their interrelationships by using the system dynamics approach. To keep the CIP/DSS financial infrastructure system dynamics model simple and integral while, at the same time, representing well the complexities of the banking and finance domain, they hypothesize that a hybrid model will effectively capture both the aggregate finance domain, view of the infrastructure and the detailed indicators that can change its behavior abruptly (Bush et al, 2005).

## 2. FINANCIAL SYSTEM INFRASTRUCTURE MODEL (FINSIM)

This is a proof-of-concept approach to the integration problem: a system dynamics-centric approach (SD-centric approach). An SD-centric approach means that the system dynamics model is the primary, controlling model and that the role of the agent-based model is to provide aggregated view of agent details when requested to

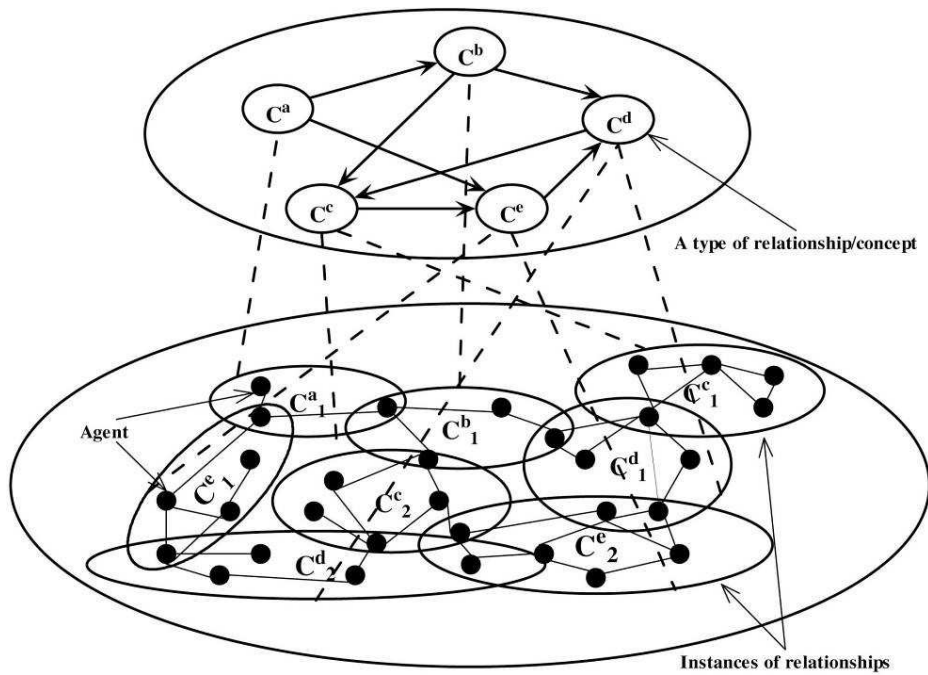


do so. Similar goals and capabilities has The Financial System Infrastructure (FinSim) developed in the US, which is an agent-based model of cash and barter transactions that is dependent on contractual relationships and a network at the Federal Reserve level. Development started in January 2005 for protection of the physical infrastructure payment and trading systems initiated by the events of 9/11.

FinSim represents the U.S. financial services sector as a complex decentralized system with multiple interacting autonomous decision nodes, or agents. Those nodes represent different types of real-world agents, such as banks, traders, markets, and brokers. Each agent has its own decision-making rules or capabilities, ability to retrieve and process information, ability to execute their decisions, and ability to interact with other agents or systems (Outkin & Flaim, 2006).

### 3. NETWORK-CENTRIC MULTI-AGENT ARCHITECTURE

The development of the mentioned approaches and current agent architectures motivate the appearance of the new Network-Centric Multi-Agent Architecture (NCMAA) (Yang et al., 2008), which is purely based on network theory (Wasserman and Faust, 1994; Dorogovtsev and Mendes, 2002). The system is designed on the concept of networks, where each operational entity in the system is either a network or a part of a network. NCMAA adopts a two-layer architecture (Chart. 4.2.). The top layer, called the influence network, defines the relationship types and how one type of relationship influences other types. Each of these relationship types is reflected in the bottom layer by a set of agents who interact using that relationship. The influence of vision on communication would form a connection in the top layer.



*Chart.4.2. – Two-layer architecture in NCMAA*

We can conclude that this approach reflected in Chart. 4.2. can help for successful transformation of the model presented to Chart. 4.1. On those two levels the building structures-European Systemic Risk Board (ESRB) (first level) and the European Supervisory Authorities (second level) can be regarded in influence network with centers of critical importance for the stability of financial and banking system in Europe. The top layer, called the influence network, will reflect in the bottom layer by a set of agents who interact using that relationship. Developed models for agent-based simulations may provide cascading effect, which is a major source of vulnerabilities in critical infrastructure systems. So for example the desirability of mergers or divisions of certain banks can be foreseen.

Influence network theory is numerous and very important applications. This theory is based on the theory of stability (Lewis, 2009).

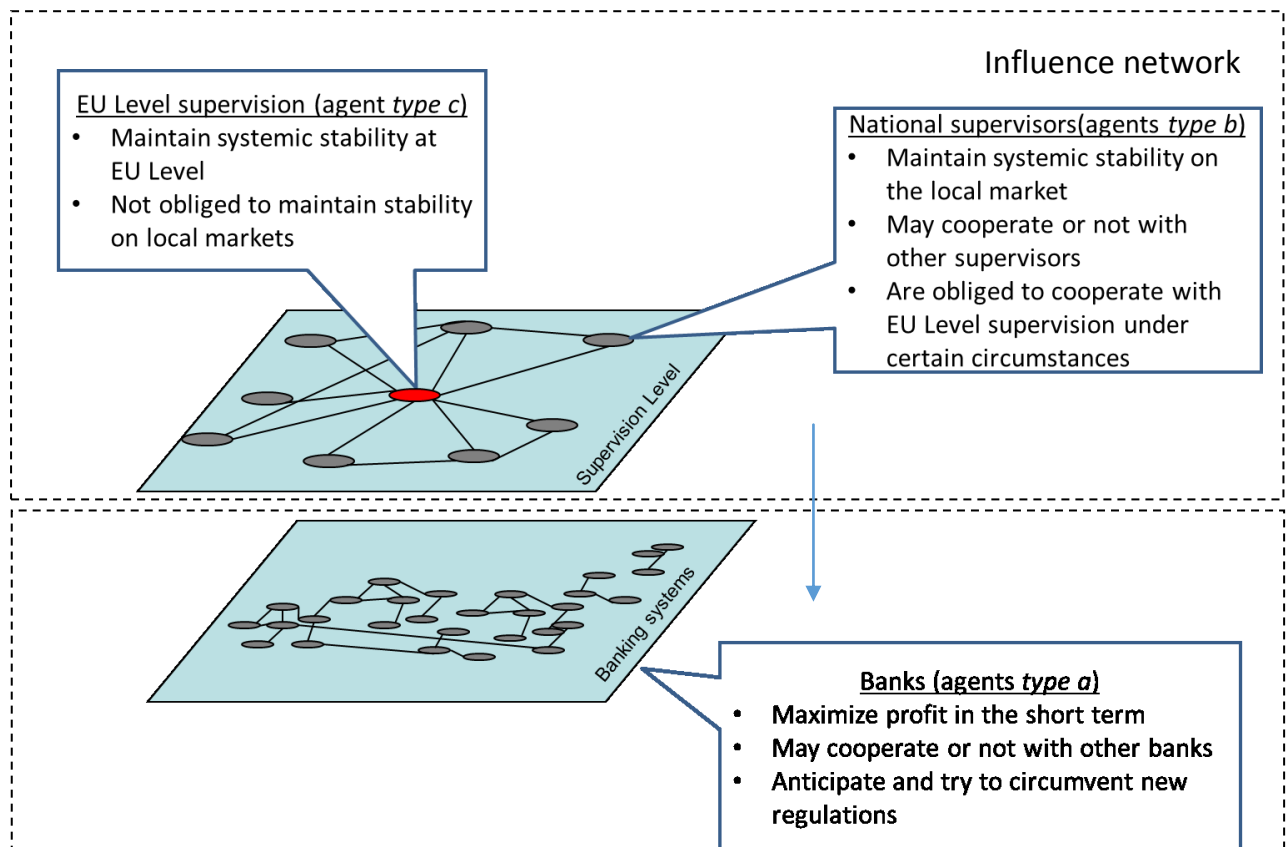
#### **4.6. Applying the concept of critical infrastructure to banking markets**

##### **– Conceptual model of network-centric multi-agent architecture for interdependent critical banking infrastructures**

To build a conceptual model we accept the views of Agent-based modeling of interdependent complex systems (Galli, 2010), the definition of agent describing the agent as a combination of location and memory capabilities, and opportunities for critical federal structure as federated (complex) agent-based model.

A critical infrastructure is characterized by its location, its behavior, interaction capabilities and its internal state. Then a critical infrastructure can be modeled as an autonomous agent and the system composed of interdependent critical infrastructures can be modeled as interacting agents which cooperate and/or compete to realize a common or an individual goal (Galli, 2010).

In the federated (complex) agent-based model, the agent is described by the combination  $(Va, Sa, Xa)$ , these values refer to three types of autonomous agents: banks (agent type "a"), national supervisory authorities (agent type "b") and supervisors at EU level (agent type "c"). These agents form a functional network of the banking system, presented in Chart. 4.3.



*Chart. 4.3 – Functional network of the banking system*

The top layer - An influence network is formed by autonomous agents - the structures of the European Systemic Risk Board and the European and national supervisors.

The interdependencies (between the agents in this influence network) form the relationships between the agents at the second level (network of banks). The relationships in the influence network form a vision for the magnitude of the risk, the necessary regulations, capital adequacy etc.

To achieve the desired security and operability we describe the influence network in terms of Network Centric Multi-Agent Architecture - NCMAA).

### **Functions of the influence network:**

The dissemination of information requires a robust communication network. The decision-making process has the following components:

- **the financial information component**—retrieving information from the banking system;
- **the communication component**—communicating the financial information to the national supervisors and the European Banking Authority (EBA) and communicating the decisions from the EBA to the supervisors and to the banks;
- **the simulation component**—interpreting the gathered information through stress-tests, simulations, early warning system etc.
- **the decision-making component** – defining the type of decision and the target banks;

### **Architecture of the perspective network-centric system for regulation and supervision.**

Regarding the conceptual model of the banking system, the architecture of the influence network can be represented by the following conceptual networks describing the relationships between agents:

- The decision-making network defines the decision-making hierarchy within the network structure. Each national banking system has one supervisor. The national supervisors are dependent on the European Banking Authority (EBA) in their decisions or can take decisions independently. The decisions are influenced by the current knowledge about the state of the banking network. This knowledge is derived from the information about the topology of the network (interaction network) and the financial information (communication network).
- The interaction network—if bank A has an exposure to bank B, then there is a link from Agent A to Agent B. The interaction network is also a directed graph.
- The communication network—could carry 2 types of information: financial information (situation information) and supervisory decisions. In a traditional network structure the situation information typically flows from a bank to the supervisor and from the supervisor to the EBA. Under the network-centric

structure, the situation information is distributed across the whole network. The information is “near real-time”. Under the traditional structure, the decision information is generated at the top level (from EBA), while under the network-centric structure the decisions are generated across the network, depending on the location and scale of the problem. The communication network is a directed graph.

- The operational network— defines whether a bank will form a connection with another bank, based on the bank’s current knowledge about the other banks, and is influenced by the decisions of the supervisors (the decision-making network). Shared knowledge – this network is based on information received from the interacting and communication network.
- The "shared knowledge" network – enables the visualization of analytical information regarding the risks in the system. It is appropriate that this information be available to the supervisory authorities – the European Systemic Risk Board and the European System of Financial Supervisors. For the ESFS authorities the analytical information is appropriate for the specific authorities according to the particular type of supervision.

Through selected parameters it is possible to monitor the overall condition of the financial system, and the introduction of network analyses could help identify risks and emerging vulnerabilities of the financial system in the EU.

At the highest level in the European Systemic Risk Board it is appropriate to obtain more general information on the individual sectors, but also on the efficiency of the banking system as one of the key indicators of its development. For this purpose, Chapter IV of the dissertation presents the possibility of applying the Data Envelopment Analysis (DEA) approach, which is a non-parametric frontier method. This method increases the range of tools for measuring the technological and financial efficiency of banks and provides a new opportunity to visualize the information necessary for the purposes of the regulatory analysis.

The network simulation analysis presented in Chapter III is essentially an innovative approach and a necessary complement to the traditional tools of assessing systemic risk, such as stress-tests, key risk indicators (solvency, profitability and efficiency, asset quality and structure of the balance sheet) and qualitative and quantitative assessments of cross-border banking groups.

This network simulation analysis seeks a further study of the shock on the banking system, while it provides very effective opportunities for visualization and operational impact by regulators after the analysis has been carried out.

Another valuable opportunity for obtaining operational information and for its visualization is the Critical Infrastructure Warning Information Network (CIWIN), which can be regarded and implemented as an addition to the communication network.

The possibilities for implementation of the influence network are shown in Chart 4.4 and 4.5. Chart 4.4 presents the traditional implementation of the influence network for regulation and supervision. The approach taken is the "top-down approach" in which information flows follow the hierarchy of the system, moving from bottom to top, and the decision making is from top to bottom. This strategy can also be called "hierarchical".

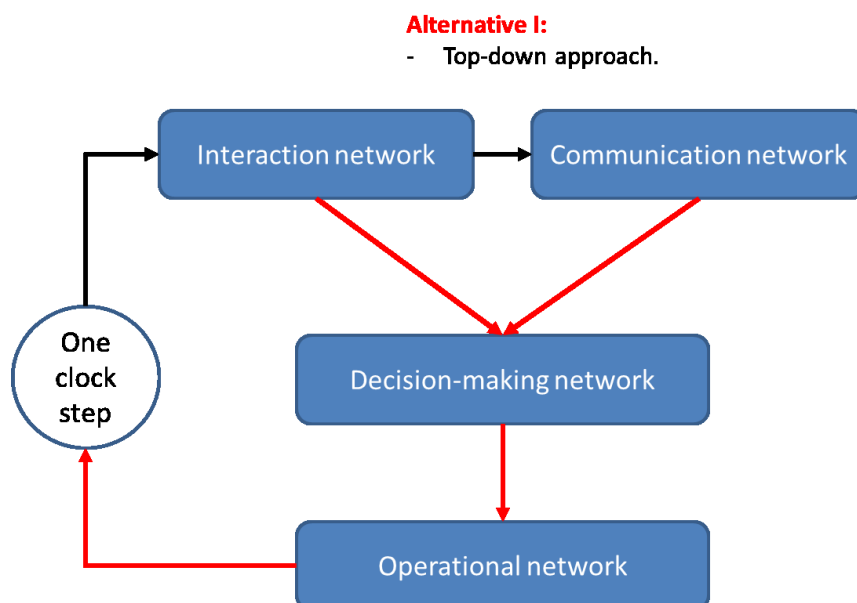
The perspective network-centric organization of the influence network for regulation and supervision shown in Chart 4.5 reflects the possibilities for disseminating information on bank transactions on a daily basis, the so-called shared knowledge. So far, this technology has been introduced only for participants on the stock exchange. The possibility stems from the fact that each bank calculates its balance parameters every day. In practice this allows the influence and control to be performed near real time, which transforms the banking system, ensuring its high operability. Furthermore, decision-making is dynamic, and different centers of decision-making are formed, depending on the size and location of an existing problem. In the current system (hierarchical strategy) most of the important

decisions must be coordinated with the European Banking Authority. There are certain procedures requiring considerable time, including time for appeal. The system is presently lacking the desired efficiency.

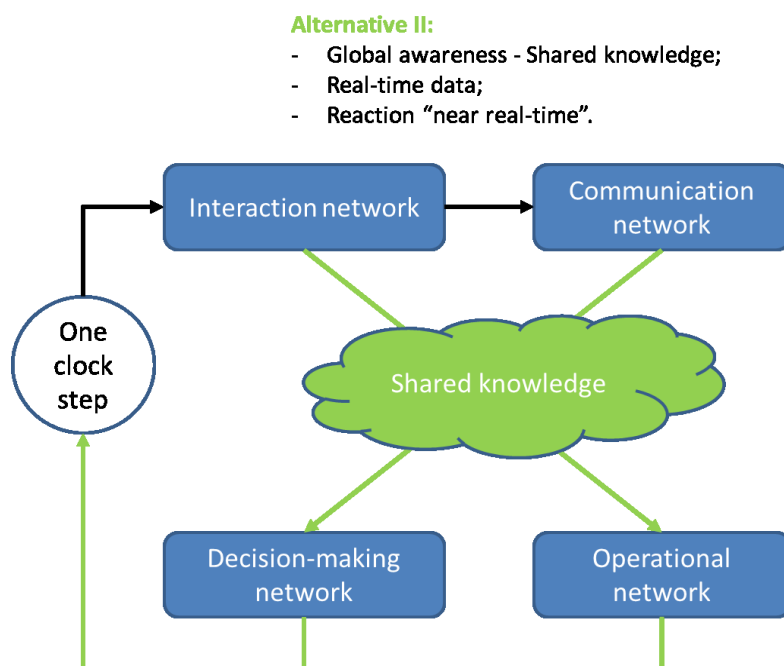
The perspective network-centric organization of the influence network for regulation and supervision shown in Chart 4.5 can be a successful solution of the views set forth in the Proposal for a Council decision entrusting the European Central Bank with specific tasks concerning policies relating to the prudential supervision of credit institutions (Council, 2012). We are referring to the possibility of early intervention measures by the ECB, when a bank has violated, or is about to violate regulatory capital requirements. This early intervention can be based both on daily on-site checks by national supervisory authorities and on current daily assessments of such bank, experiencing serious difficulties. The national supervisory authority informs the ECB on the current assessment and acts as an integral part of the Single Supervisory Mechanism.

In connection with the proposed structuring of the conceptual model of influence network, of great importance is to determine precisely the timeframe of the process of influence and control discussed above. These timeframes (the steps of the models) of the processes are shown in Chart 4.4 and 4.5. The advantage is clearly in favour of the version applying network-centric approach and ensuring high operability and security of the banking system, seen as a critical infrastructure.





*Chart 4.4 - Traditional implementation of the influence network for regulation and supervision*



*Chart 4.5 - Network-centric implementation of the influence network for regulation and supervision*

Chart 4.6 presents the hierarchy of the financial (including the banking) system of influence and control in the EU. The main idea is to build a joint analytical framework of the complex system (which includes all levels). On the second stage,

the idea is to show that with different organization of the players (the two alternative strategies), the system could be made more stable and operable.

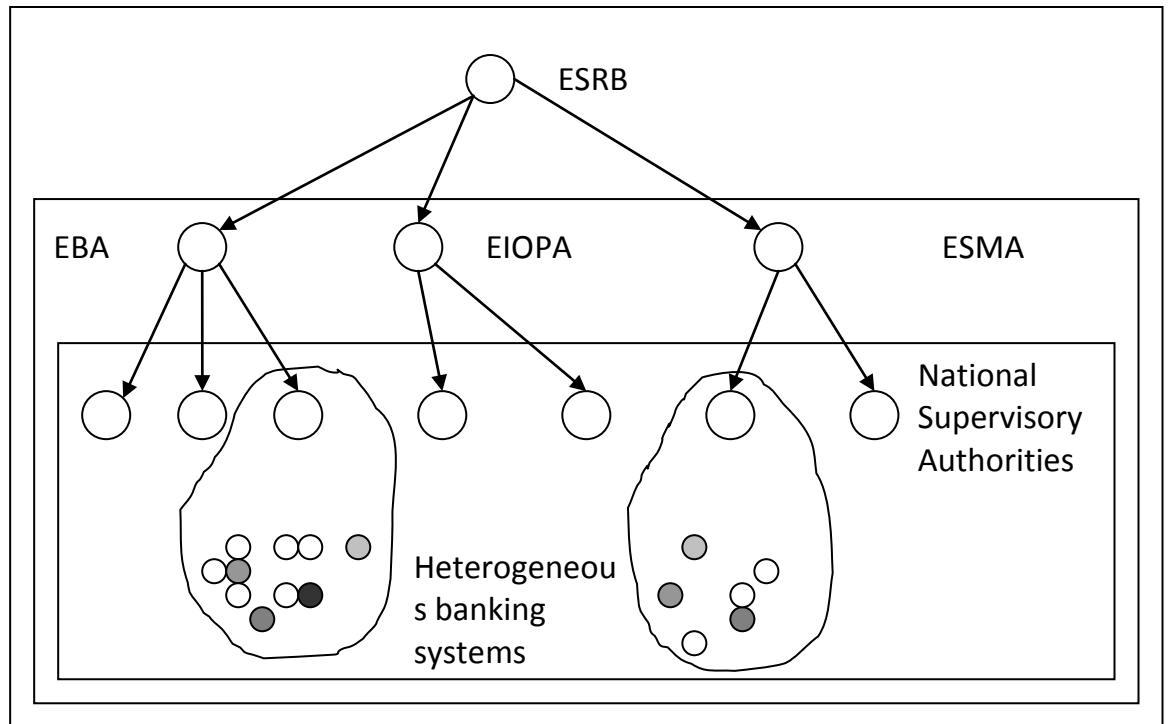


Chart 4.6 - Hierarchy of the system of influence and control

Functional network:

A “type  $a$ ” agent (bank)  $a$  is described by the vectors  $(V_a, S_a, X_a)$  where:

$V_a = \{v_1^a\}$  is an agent attribute, like: capital adequacy.

$S_a = \{s_1^a, \dots, s_{N_s}^a\}$  is the set of the outputs. These outputs are exposures to other nodes in the banking network (loans to other agents).

$X_a = \{x_1^a, \dots, x_{N_x}^a\}$  is the set of the inputs. The inputs are resources attracted from other agents in the banking network.

A shock is an unpredictable event that modifies the agent state and alters the behavior of agent  $a$ , reducing its capabilities to provide assets and repay liabilities.

A shock is present when the capital adequacy falls below a certain threshold, for example:  $v_1^a < 8\%$ .

A default is present when the capital buffer is exhausted:  $v_1^a = 0$ .

A liability is characterized by  $x_i^a = (t_x, x)$  where  $x$  is the value of the liability and  $t_x$  the time at which the value  $x$  is available.

The agent state (stability) is modeled by the agent attribute  $V_a$ .

$S_a$  and  $X_a$  model the capability of the agent to interact with other agents by providing assets and attracting liabilities.

### **Agents' interdependencies:**

The relationship among agent attributes, outputs and inputs:

The agent state  $V_a$  is function of the time and of the agent outputs  $S_a$ . Assuming that the time is discrete, and that each agent attribute  $v_i^a$  depends on a subset of the agent outputs  $\{s_{j_1}^a, \dots, s_{j_n}^a\}$  we have:

$$v_i^a = f_i^a(t, s_{j_1}^a, \dots, s_{j_n}^a)$$

$t$  denotes the clock steps.

Two agents:  $a1$  and  $a2$  interact if exist at least one output provided by  $a1$  that is an input for  $a2$ :

$$s_i^{a1}(t) = x_j^{a2}(t)$$

for some  $1 \leq i \leq N_s^{a1}$  and  $1 \leq j \leq N_x^{a2}$

Furthermore the output activities depend on the capital levels of the bank and on the regulatory environment (limits, restrictions):

$$s_i^a = f_i^a \left( t, v_{j_1}^a, \dots, v_{j_n}^a, s_{j_1}^b, \dots, s_{j_n}^b \right)$$

A bank chooses to which bank to lend in a semi-random process. The more capitalized the target bank is, the higher the chance is to be chosen. The bank limits its lending activities when it is close to 8% capital adequacy. A second option is: the more interconnected the target bank, the higher the chance to be chosen. This is in line with the idea for scale-free network with hubs.

### **National supervisors:**

An agent “type  $b$ ” (national supervisor) is described by the vectors  $(V_b, S_b, X_b)$  where:

$V_b = \{v_1^b\}$  is a set of the agent attribute – budget (bail-out-ready funds).

$S_b = \{s_1^b, \dots, s_{N_s}^b\}$  is the set of the outputs. These outputs could be regulations (limits), individual restrictions, bail-outs.

$X_b = \{x_1^b, \dots, x_{N_x}^b\}$  is the set of the inputs. The inputs could be the stability (attributes) of all the agent type  $a$  in a particular jurisdiction, decisions and actions of other agents type  $b$ , etc.

### **Agents’ interdependencies:**

The relationship among agent attributes, outputs and inputs:

The agent output is function of the agent type  $b$  inputs, and the outputs of the agents type  $c$  (the behavior of the national supervisor depends on the stability (attributes) of the local banks and the decisions made by the EU level supervisors)

$$s_i^b = f_i^b(t, x_{j_1}^b, \dots, x_{j_n}^b, s_i^c, \dots, s_n^c)$$

The agent state  $V^b$  is function of the time, of the agent *type b* outputs.

$$v_i^b = f_i^b(t, s_{j_1}^b, \dots, s_{j_n}^b)$$

Agents inputs depend on the agents *type a* attributes (*the stability of the banks: the capital buffers of the banks*):

$$x_i^b = f_i^b(t, v_1^a, \dots, v_{N_v^a}^a)$$

### **EU level supervisor:**

An agent “type *c*” (EU level supervisor) is described by the vectors  $(V_c, S_c, X_c)$  where:

$V_c = \{v_1^c\}$  is a set of the agent attribute, like: bail-out-ready funds, credibility.

$S_c = \{s_1^c, \dots, s_{N_s^c}^c\}$  is the set of the outputs. These outputs could be regulations, bail-outs, decisions concerning individual agents *type b*.

$X_c = \{x_1^c, \dots, x_{N_x^c}^c\}$  is the set of the inputs. The inputs could be the stability (attributes) the EU banking system and the attributes of agents *type b*.

### **Agents’ interdependencies:**

The relationship among agent attributes, outputs and inputs:

The agent output is function of the agent *type c* inputs (*the decision of the agent type c depends on the stability of the banks and the performance of the national supervisors*):

$$s_i^c = f_i^c \left( t, x_{j_1}^c, \dots, x_{j_n}^c \right)$$

The agent state  $V_c$  is function of the time, of the agent *type c outputs*.

$$v_i^c = f_i^c \left( t, s_{j_1}^c, \dots, s_{j_n}^c \right)$$

Agents inputs depend on the agents' *type a* and *type b* attributes (*stability and performance of the banks and national supervisors*):

$$x_i^c = f_i^c \left( v_{j_1}^a, \dots, v_{j_n}^a, v_{j_1}^b, \dots, v_{j_n}^b \right)$$

It is appropriate to upgrade the specific heterogeneous structure of the banking system (network), described and developed in Chapter III of the dissertation, with the influence system of supervision realized as network-centric multi-agent architecture.

**The resulting combination is proposed as a conceptual model of the banking critical infrastructure, realized through the network-centric approach.**

#### **4.7. Methodological prerequisites for the implementation of the network-centric approach**

The new organization for unified banking supervision, a new pan-European deposit guarantee scheme and the single European framework for restructuring and recovery of the institutions proposed by the European Commission can be effective only at high operability, the achievement of which requires appropriate methodological prerequisites for implementing the network -centric approach.

The setting of new requirements, new structures and new relationships, in particular those for adapting the existing EBA regulation to the new regime for banking supervision upgrades the hierarchical system, but also increases its

complexity. To this we have to add the need for the Single supervisory mechanism to monitor nearly 6 000 banks in the Euro zone. The establishment of a new strong centralization of the control (command) structure, headed by the ECB, is likely to result in delayed reactions along the hierarchical administrative structure, and respectively, along the regulation-supervision chain. In order to avoid such undesirable effects it is appropriate to introduce a modern approach and tools to achieve interoperability (operability, pace) in the unified financial (banking) system.

The effective implementation of the above plans and proposals under the European Commission will obviously require a new methodology for the intended activities. Here the operability becomes of prime importance. Accordingly, a new model is needed for the hierarchical system, corresponding to other operating systems, for example in the field of security, in particular the military systems.

In this regard, we examine the applicability of basic methodological aspects of the network-centric approach (Ahvenainen, 2003), typical for highly operative and responsive systems, including business systems operating in near real time. We pay attention to specific aspects concerning applications in the financial (banking) structure, to which our interpretation is directed.

Most network organizations reduce the number of organizational levels and create a direct link to the source of information, increasing the pace of operations.

The pace (time) is central to success, in this way most network organizations become better adapted to the complex and dynamic situations. Operability is crucial to success, especially if the organization has room for competition. The network allows for increasing the pace when the level of management and control is low (insufficient). In this case, the information disseminated throughout the network compensates for the lack of administrative guidance. The management is transformed into dissemination of necessary information and thus the information is substitute for other resources.

The interaction within the network and the cooperation at the horizontal level is a basic requirement. The cooperation forms a concentrated effect of distributed power (Ahvenainen, 2003). At the horizontal level there is opportunity for management and control, information exchange, congruent goals of the agents (in winning situations), division of labor and responsibilities.

The network-centric approach involves primarily the application of new information and communication technologies, as well as a new doctrine and new ideas for operation. New organizations using these technologies and doctrines are being created. The modern complex and dynamic systems require more information and knowledge, and the process of transformation requires the necessary self-organization and operability.

The network-centric approach works primarily bottom-up, while the hierarchical system works in the reverse order. The information comes from the bottom or from the neighbors with a possibility for self-synchronization between them. The possibility to share information is key to achieving shared knowledge based on advanced technologies in communications. This approach is essentially an integrated communication, integrated interaction and appropriate management and control, enabling distributed interactions in the system. "Distributed" means the distribution of management and control over the entire network and an integrated use of resources.

The essence of the network-centric approach is the possibility to exchange information in the composition of the so-called "influence networks". This is of key importance for the achievement of shared knowledge in the executive departments as an opportunity for cooperation and synchronization.

Based on the modern information technologies it is necessary that the information from the operational level is combined with the information coming from the hierarchy. This gives full awareness and the necessary networking capabilities of the system, and secures operational compatibility.



In summary, we should point out that the required operability is achieved by:

- reducing the levels of management;
- increasing the network activity;
- self-synchronization, in terms of achieving the objectives of the hierarchy by reducing the number of levels of interaction;
- self-synchronization requires the presence of advance information and achievement of higher quality of the operations.

#### **4.8. Network supervision - a new organization of supervisory processes in a network-centric environment**

The new type of organization of the influence and control processes is a prerequisite for a network-centric supervision and regulation. It is a promising alternative to the institutional, functional and targeted supervision models.

##### **4.8.1. How to structure the network supervision?**

The issues concerning the structuring of the network supervision can be summarized in the following categories:

- Participating countries;
- Categories of financial institutions included in the network supervision;
- Institution responsible for the supervision activities;
- Institution responsible for the restructuring of distressed banks;
- Degree of centralization of the financial resources for the network supervision;
- Sources of financial resources for the network supervision;
- Structure and management framework of the network supervision.

According to the authors (Pisani-Ferry et al., 2012), the main purpose of the banking policies is to ensure the proper functioning of the financial intermediation exercised by the banking sector. To achieve effective prevention and crisis management, the banking policies rely on four pillars: regulation, supervision, deposit guarantee and bank restructuring.

The regulations aim at strengthening the banks' resilience to shocks and reducing the secondary effects resulting from a bank failure with a significant impact on the economy and society.

The Supervision allows monitoring the banking activity and the risk-taking in order to ensure that they are managed in the best way.

The Deposit guarantee is intended to counter the threat of bank run by protecting the value of deposits.

The Bank restructuring allows reorganization or restructuring of a bank without significant negative consequences for the system and ideally without the use of taxpayers' money.

In the European context the bank policy is highly integrated (Pisani-Ferry et al., 2012) in comparison with other regional unions; however, most of the policy instruments are currently at the national level. Banking regulations are highly harmonized as a result of the Financial Services Action Plan (FSAP), adopted in 1999. The undertaken measure to create a single rulebook is also taken into account, but presently the supervision, deposit guarantee and bank restructuring remain at the national level. As regards the supervision function, coordination mechanisms exist to some extent, including via the European Banking Authority established in 2011. In the area of Deposit guarantee there is a partial harmonization, the minimum threshold is set at 100 000 EUR, but the systems, structures and funding methods themselves vary considerably. The Restructuring of banks is also at the national level, and some countries have not even adopted regulations in this area.

To be effective, the network supervision has to cover the mentioned four pillars. The different functions can be allocated to different institutions, but in any case they must be at one (supranational) level, which is the network supervision.

#### **4.8.2. Banking regulations**

At the European level, an initiative was taken to align the implementations of EU regulations, and to this end the major projects are now adopted as regulations which are directly applicable in the Member States and do not need to be reflected in the domestic legislations. In this way are avoided differences in the interpretation and implementation of the various requirements. On the other hand, the more technical issues are governed by "mandatory standards", the majority of which will be issued by the EBA. These standards will again be directly applicable in the Member States.

#### **4.8.3. Fiscal responsibility for the network supervision**

In order for the network supervision to be effective, the institution must have a budget for interventions. The means may be provided from a fund established for this purpose. These funds may be raised from banks under the deposit guarantee scheme or in the form of taxes or fees, or from the countries participating in the respective network supervision. Alternatively, the funds may come from the subsequent distribution of incurred expenses. In any case, a common financial buffer is required for the efficient functioning of the institution. Reliance on local budgets would put at risk the effectiveness and the timeliness of response of the network supervisor.

The establishment of common fund entails other risks (Pisani-Ferry & Wolff, 2012), which need to be considered. On the one hand, a fair criterion must be observed for the allocation of the financial burden to the countries or banks. On the other hand, the common fund could lead to moral risk. The aggregation of risk at a

supranational level can stimulate individual states to implement less responsible policies with regard to the financial system, since the potential losses will be suffered by all participants in the network supervision.

The common fund leads to yet another difficulty (Pisani-Ferry et al., 2012) related to the different currencies in the different countries participating in the supervising authority, for example when it comes to the inclusion of countries outside the euro area. This situation could lead to difficulties in coordinating the policies of the central banks' individual liquidity policies.

#### **4.8.4. Banking supervision**

The current financial system relies heavily on institutional regulation and supervision (Heremans, 2000). Banks, investment firms and insurance companies are supervised by different institutions. The situation is getting more complex when market participants extend their activities and their interconnectedness. In such case, a close coordination of the supervisory requirements is required in order to avoid regulatory arbitrage. The network supervision based on consistent prudential requirements for the institutions in the network could avoid this drawback of institutional oversight.

The organization and distribution of functions for supervision and restructuring of troubled banks are essential to the effectiveness of the network supervision. In this regard, the main features of the new organizational framework of the supervisory processes in a network-centric environment are outlined in the following paragraphs.

#### **Network segmentation**

Depending on the network structure, the different, relatively independent parts of the network could be covered by different supervisors. These segments can be built around a hub (large, systemically important banks) or covering a concentration of connections without the involvement of a hub. The condition of the segmentation is the sub-networks to be relatively autonomous, i.e. the internal

borders of the network should be identified – areas with a low concentration of connectivity.

The network segmentation determines also the range of countries that participate in the network supervision. If there is more than one sub-network (segmented network), a particular country can be covered by two or more network supervisors.

### **Network dynamics**

Regarding the network dynamics, if the network is volatile, one should be looking for the stable connections and trends such that the supervisory responsibilities could be allocated according to them. A review of the network topology is conducted at specified periods (for example – one year), and the allocation of the supervisory responsibility is reviewed accordingly.

### **Network approach**

The network approach is close to the functional supervisory approach in which the individual networks: payment systems, capital markets, debt markets, investment markets, etc. are based on different functions of banks. Since some networks are interconnected or are overlapping institutionally, in such case they can be regulated by a single network supervisory authority.

### **Inclusion of all financial institutions, connected in the network**

All financial institutions involved in the network should be included in the scope of the supervision. Extending the network supervision beyond the banks would allow coverage of other non-bank financial institutions (insurance, investment companies, etc.) involved in the network. Thus a regulatory arbitrage will be avoided by market participants by transferring parts of banking activities to non-bank institutions. The unification of the supervisory treatment would reduce the value of such activities and will deal with the problem "shadow banking". The extending of the

scope of the supervision to cover all participants in the network is shown as a possibility in *Chart 4.7*.

Upon establishing such joint supervisory structures, there is a view that it is necessary to supervise only large, systemically important banks, and the rest may be dealt with by local supervisors. In the context of network supervision that would include only hubs. Such a situation would create differences in the supervisory treatment in the individual institutions. On the other hand, the thus defined scope would fail to include a banking cluster in which there is strong interconnectedness, but no clearly outlined hub. To overcome such situations, we propose the inclusion of all institution, connected in the network.

### **Institution for bank recovery and restructuring**

The function of recovery and restructuring can be delegated to the network supervisor or to another institution established for this purpose. In the second case, such institution should have the same scope as the network supervision. To ensure its effectiveness, the institution must have at its disposal a fund with which to operate when needed. The alternative, where funding is allocated to and collected from the member states on a case-by-case basis, would reduce the efficiency and the ability to respond rapidly and suppress shocks in the system. This in turn would lead to a negative impact on the function of the network supervision.

### **Scope of the network supervision**

We consider that the definition of the scope of the network supervision should be closely linked with the concept of the interruptibility. It is advisable that the supervisory authority cover all financial institutions (banks, insurance companies, investment companies, etc.), which are materially interconnected, not depending on whether they are part of a group or are connected to each other by exposures or otherwise.

We can define "material interconnection" as a link between individual companies, which could not be broken without causing negative effects on the activity of at least one of these companies.

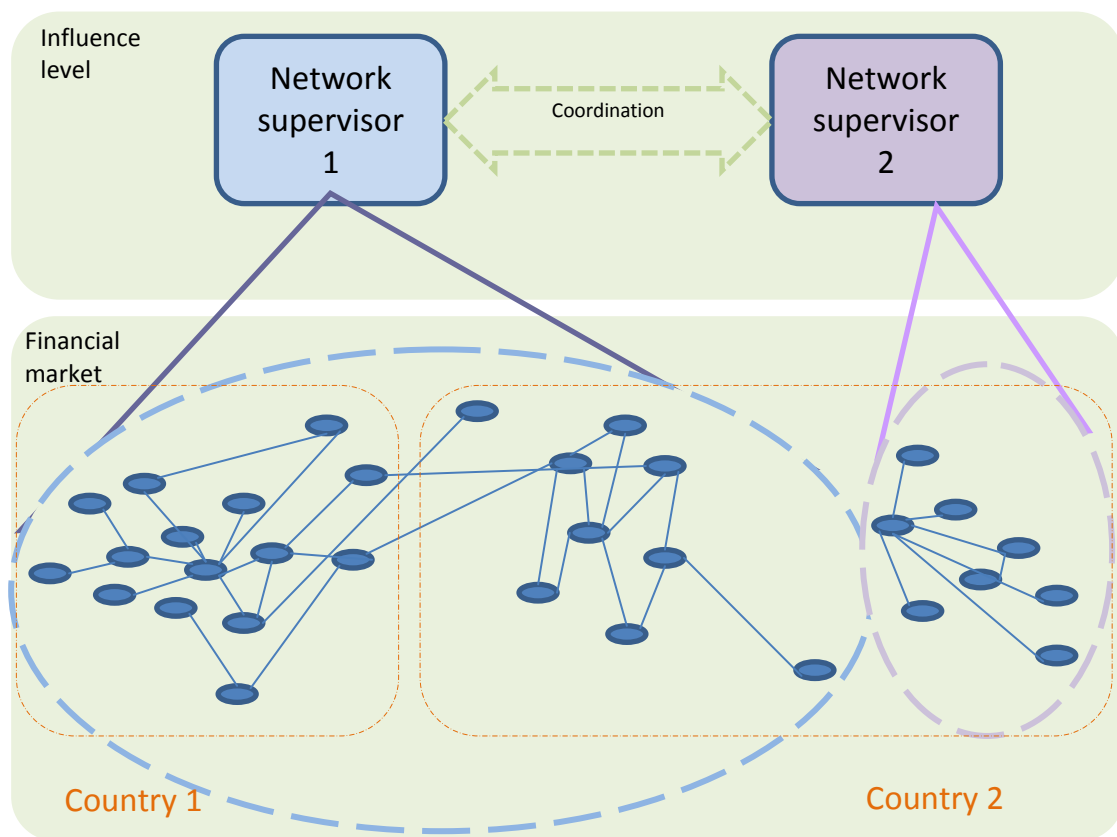
Upon determining the scope of the network supervisor, the actual topology of the network and the essential connections between the financial institutions should be analyzed. If we can demonstrate that a connection can be interrupted without negative consequences, the company at the end of the connection could be left outside the scope of the particular network supervisor.

The traditional hierarchical systems have limited internal interconnectedness and therefore are easily interruptible (Haldane, 2009). Modern financial systems evolve in the opposite direction, increasing their internal complexity and interconnectedness, and thus reducing their discontinuity. Structured financial products also help to enhance the relationship between institutions and sub-structures in the network, making it virtually non- interruptible.

Metaphorically, we can say that the scope of the network supervision follows the boundaries of the different risk areas, determined by the structure of the financial market.

### **Structure of the network supervision**

*Chart 4.7* presents a sample structure of a network supervisory architecture. One of the main characteristics of the network supervision is its close position to the network, i.e. knowing its peculiarities and having up-to-date information about its condition would allow the supervisor to react promptly on a problem in one of the nodes.



*Chart 4.7 - Structure of a network supervision*

This structure can be applied both domestically and in a cross-border context. At the international level (e.g. EU level) the day-to-day oversight of individual financial institutions, i.e. operational supervisory activities, could be handled by the network supervision authority using the expertise of the local supervisors. This will overcome the potential problems arising from the fact that the supranational body does not have the most detailed knowledge about the peculiarities of individual institutions.

The network supervisor could overcome the serious problem of coordination and distribution of responsibilities between the home and host supervisory authorities of the financial institution when there is a case of a cross-border financial group. This is possible because the network supervision will cover the essential relationships (links) along which a need for coordination in problem solving could emerge.



At the EU level, for example, if there is more than one supervisory institution, it is necessary to coordinate between them. This coordination, however, will be mainly in the field of synchronization of supervisory practices specifying the supervisory requirements introduced in the EU. The need for coordination upon imposing specific prudential measures is unlikely to occur, because the lack of material connections between the individual networks, supervised by individual network supervisors, determines the absence of such situations. If subsequently such material connections do arise, it will be necessary to review the respective network supervisions.

The management and decision-making by the network supervision must involve local supervisors responsible for the institutions covered by the network supervision. The effective functioning of that supervision requires the establishment of effective rules of voting and management.

The regulatory function should be performed by a separate institution, as the scope of network supervision will not match exactly in individual countries or regions. In the European context, the European Banking Authority can perform this task. It can serve as a platform for coordination between the individual network supervisions (if it is necessary to establish more than one).

### **Information availability in the network supervision**

Although there is no "universal" supervisory model for each situation and each market, the general formula for effective supervision is always to have comprehensive and up-to-date information (Masciandaro & Quintyn, 2009). The application of this rule is not so easy, though. When markets were relatively static and segmented, the information about the status of the system at a point in time, collected at certain periods, was sufficient. In such cases the vertical supervisory model would logically be the most effective solution.

A fundamental principle is that the frequency of data collection must conform to its dynamics. Nowadays, the dynamics of the financial market requires constant

updating of information. Based on the modern information technologies, the achievement of shared awareness, using "near real-time" information, would not constitute a difficulty. The positive effects of this common knowledge far outweigh the cost of achieving it. This information will allow the real-time regulation of the system, in a manner similar to the classic critical infrastructures. There is a possibility to use a wide range of tools for timely identification of potential risks, such as simulations, stress-tests, risk dashboards, etc. If this information is available to the market participants (depending on the adopted market structure), this would result in the possibility of self-synchronization of the system, enabling proactive responses of the market participants in the event of systemic problems.

In both cases, supervisors and market participants have to invest in new analytical tools (Haldane, 2009). The analysis of individual participants as VaR analysis does not show clearly the stability of an institution. It is necessary to give consideration to the network analysis, for instance analysis of the distribution of connections and the average length of the connections. To these static indicators must be added dynamic indicators, reflecting the dynamic stability of the system. A possible tool for this type of analysis is the simulation of a collapse of a certain core. Stress testing should change the focus from individual to systemic risk.

#### **4.8.5. Alternatives to network supervision**

The proposals for cutting of the "too big to fail" banks would not lead to satisfactory results, because the individual institutions will remain interconnected in a network, which still poses a systemic risk. Similar ideas for dismantling of big institutions are set out in the "Vickers report" (ICB, 2011), which provides a framework for reforming the financial markets in the UK, and in the "Liikanen report" (Liikanen, 2012), which provides a framework for stabilizing the European financial market (in parallel with the introduction of the European version of Basel III). The "Vickers report" offers the separation of the retail functions of the financial institutions from their riskier activities. Similarly, the "Liikanen report" offers the

possibility of taking out the risky trading activities from the financial institutions. The two proposals are similar in nature, emphasizing on the separation of activities important to the economy from those that are highly risky. In fact, the risk is not mitigated, because even separated, the individual companies remain in one group and the channel for shock transmission (capital ties, mutual exposures, etc.) remains active, this is valid also for the reputation risk, which can easily lead to a bank run.

The interruptibility is an important concept in the analysis of systemic risks. If it is possible to interrupt network links that threaten its stability, it would be an effective means of stabilizing the economy. The above proposals are aimed at that idea. The real question is how interruptible the links are. This crisis has shown for example that securitization schemes that were considered effective for breaking the link between exposure and risk, actually didn't perform this function effectively and required implicit support from their initiators in times of market turmoil.

#### **4.8.6. Macro-prudential dimension of the network supervision**

Macro-prudential policies are defined as policies using primarily prudential tools to limit systemic financial risks (IMF, 2011). Whether the macro-prudential policies are considered a new type of function or a reorientation of existing regulatory policies, their success depends on two factors: access to information and a selection of different tools of impact (Nier et al., 2011). It is not by chance that macro-supervision is associated with the central banks as institutions having financial information. However, these often have information limited mainly to the banking market, not covering other sectors of the financial market. The network supervision has the advantage of being an institution that covers various market participants, especially as its scope follows the boundaries of the system of different but interconnected institutions, thereby facilitating actions to reduce systemic risks.

#### 4.8.7. Network supervision and the supervisory and regulatory framework in the EU

In September 2012, the European Commission published a proposal for the establishment of a supervisory mechanism as a step towards the creation of Bank Union (Council, 2012). The recently adopted supervisory mechanism aims to make the transition from the current model of allocated responsibilities with coordination mechanisms to a model of centralized bank supervision, covering all banks in the euro area, and later throughout the EU. It is envisaged that the ECB will take on the role of this single supervisory authority.

The EC proposal is somewhat compatible with the concept of network supervision, to the extent that the intention to transfer the basic supervisory rights and responsibilities from the national to the EU level has been clearly expressed. This confirms the view that coordination is an insufficient mechanism to deal with the problems of the financial system.

The differences between the network supervision model and the newly adopted role of the ECB are essential at this stage. It has been shown that the centralization of supervisory functions often does not lead to greater efficiency and often increases administration. In addition, the vertical supervisory model remains active, where the ECB will have responsibilities only for the banking sector. For the other sectors of the financial market the new EU framework does not provide the establishment of such structures. The inefficiency stems from the fact that the supervision mechanism builds on the current "Lamfalussy" model. The European Banking Authority (EBA), one of the "Lamfalussy" structures, is a collective body and every major decision should be adopted by its Board of Supervisors, in which participate representatives of all banking supervisory authorities in the EU. That, and the way the body works, determines the relatively slow process of decision making. The involvement of the ECB in the supervision framework adds an additional layer of coordination and administration, as the ECB assumes the rights of national

supervisors involved in EBA, and any decision by the ECB in this area is also subject to a final vote by the Governing Council of the ECB, in which almost the same representatives of national supervisory authorities participate. The overlapping of administrative procedures, response times and coordination mechanisms determine the slow performance of the new structure.

#### **4.8.8. Advantages of the network supervision**

One of the main advantages of the network supervision architecture is that it would be particularly effective in a highly integrated market and in the presence of various institutions, groups and conglomerates operating in various sectors of the market, while not requiring the presence of multiple regulatory and supervisory institutions.

By regarding the financial system as a complex adaptive system, we can apply some of the analytical techniques from other network disciplines such as ecology, epidemiology, biology and engineering. (Haldane, 2009). Using a network perspective, we see from a different angle the structural defects accumulating in the financial system, and can offer means to improve the stability of the system. Using the network theory, we can explain the emergence of two main characteristics of the financial system – its complexity and homogeneity. Together, they make the system both susceptible and resistant – a feature common to other complex adaptive systems. As seen from the analysis in Chapter III, the network system has a definite turning point. Up to a certain point the network links serve to absorb shock by allocating small part of it to the participants, thus diluting it. But after a certain point the behavior of the system turns and the links begin to help spread the shock, instead of mitigating it. Often the systemic effect is not proportional to the initial shock.

The structure of the network is also asymmetric (Haldane, 2009). A random network is expected to have a normal distribution of interconnectivity, as measured by the number of links to various cores. But the financial system has, like many other

systems such as epidemiological networks, food chains and internet networks, asymmetric distribution of links. There are a number of cores with lower and higher number of links than the average for the network. Researchers demonstrate that networks with such "scale free" distribution are more resistant to random attacks, but are vulnerable to targeted attacks (Porterie et al., 2008). This characteristic of the financial networks is evident also from the analysis that we made in Chapter III. Targeted attacks are more dangerous because if the target is a hub, this could easily lead to system crash. The "small-world" effect inherent to these networks also influences the susceptibility. These types of networks are more likely experience local problems in the system (Porterie et al., 2008).

The stress in the system increases its vulnerability, as in the spreading of certain diseases (Haldane, 2009). The size and complexity of the system increase the uncertainty and make it difficult to evaluate the assets. The financial innovations in the form of a structured product increase further the complexity and uncertainty of the network. On the other hand, the diversification of the system is undermined by the market participants' business strategies and risk management techniques, making the system more fragile to shocks – resembling the marine eco-systems whose diversity decreases and this increases their susceptibility to failures. The evolution of the network topology suggests that the occurrence of sudden interruptions (shocks) is a matter of time. From this viewpoint, the current crisis is the materialization of this type of event.

We believe that the network supervisory architecture is best suited to respond to the evolution of the financial system and prevent system failures, because the focus is on the interaction between market participants, not only on their individual stability. From this perspective, it is possible to take a complex approach treating both the causes for and the consequences of the shock.

The idea of implementing a network-centric approach in the financial sector is an attempt to address the need to develop techniques for transformation of the

financial (banking) system from a structure with a consequent (delayed in time) management and regulation, into an operational self-regulating system (system of systems) operating near real-time. In the case of the financial system, this transformation aims at transition from a system where supervisors take action against certain problems after their identification and analysis, which requires considerable time. The goal is the response of supervisors and market participants to follow immediately the appearance of a specific problem and depending on the scale and nature of this problem, different cores are dynamically formed, which allows swift response. This rapid response in the network would be possible because of the availability of timely and adequate information. This would achieve the transformation, allowing substantial increase of the stability and the efficiency of the entire system.

#### **4.8.9. Opportunities for practical implementation of network-centric supervision**

The idea is to extend the scope and the means for action in Crisis response operations (CRO). These techniques have proven their effectiveness in practice with the operation of joint multinational structures in basic areas of security (military and humanitarian). In times of financial crisis, the operations for stabilizing the banking system could be performed by the establishment of integrated (internationally) joint financial supervisory structures (Mirchev, 2013). This joint structure is appropriate to have the following functions:

- regulation and supervision of financial activities in specific emerging crisis;
- restructuring of financial structures;
- centralization and distribution of financial resources required for network supervision refinancing operations.

The possible joint integrated supervisory structures (JISS), assigned to a particular network or network segment, must be authorized by senior management of the Single Supervisory Mechanism (SSM) that determines the necessary financing.

On this basis, in the normal situation the different joint supervisory structures (banking, insurance, securities, etc.) should be trained through a cross-border/domestic financial crisis simulation exercises for the simulation of possible scenarios for crisis management and implementation of contingency plans.

The JISS will be reinforced when there is a need for real action on crisis management. A supervisory crisis center is created. These structures act essentially decentralized in that given network or network segment based on the powers and responsibilities delegated by the central European authority (the SSM for example). Thus emerges also possibilities for managing of cross-border financial crises when there is an interaction of financial institutions from countries with significant banking interrelationships.

After completion of the crisis management, in the supervisory crisis center will remain surveillance team and the other experts will return to their usual assignments.

On the basis of the implemented activities, an after action review, and lessons learned analysis and recommendations are elaborated for responding to such situations and for providing the necessary financial stability.

#### **4.9. Aim of a Network-centric approach application**

The aim is to develop a methodology for a comprehensive assessment of a critical infrastructure. The proposed methodology for assessing the elements of a critical infrastructure (CI) is based on the following principles:

For an aggregated measure of the criticality could be taken the risk assessment of an object/system.



The risk  $P_n$  is defined as:  $P_n = f(\text{threat} * \text{probability} * \text{consequences})$

$$P_n = f(T * P * C)$$

The threat  $T$  to the critical object could be driven by cascade effects. A measure of the threat is its intensity/force.

The probability  $P$  for occurrence of the above-mentioned threat is the second factor.

The consequences  $C$  are the direct losses, which the object provokes by its disfunctioning.

The risk assessment for a given object or system can be regarded as an aggregate measure of the infrastructure's criticality. For our method, this formula could be modified. First of all, to meet the essence of the CI, we add another element, which takes into account the network-centric structure/technology.

The Network-centric influence  $N_c$  is assessed as a factor reducing the level of anticipated losses.

$$P_n = f(T * P * (C - N_c))$$

#### **4.10. Conclusions from the application of the critical infrastructure concept and network-centric approach to banking markets**

The application of the critical infrastructure paradigm in estimating the vulnerability of the banking system and the introduction of the here developed simulation modeling directed to network-centric multi-agent architecture for interdependent critical banking structures allows achieving high operability and security of the banking system.

The development of the proposed conceptual dynamic model of the banking system allows its improvement as a reliable component of the joint system of security and stability.

The network supervisory architecture is best suited to meet the evolution of the financial system and prevent system failures, because the focus is on the interaction between market participants, not only on their individual stability.

The new type of organization of the influence and management processes necessitates the network-centric supervision and regulation. It is a promising alternative to the institutional, functional and targeted supervision.

## General conclusions

This study is an attempt to respond to the need to develop and propose ways for transformation of the current banking system structure that operates with delayed-in-time management and impact, into a self-regulating operating system that works in near real time. This change would allow a significant increase in the stability and efficiency of the system. Thus, this study is an attempt to generate interest in the possibility for the application of innovative approaches and tools for transformation of the banking system.

The new unified organization of banking supervision, proposed by the European Commission, the new pan-European deposit insurance and the common European framework for the restructuring and resolution of financial institutions can be effective only in high operability. To achieve the necessary transformation of banking system it would be appropriate to provide near real-time operational information to the centralized European Banking Supervision, which will allow them to decide on banking measures, resolutions and needs of recapitalization. It would also be appropriate to allow the centralized European Banking Supervision to perform its duties in a network manner in response to the dynamically changing network structure of interconnected banks.

In order to contribute to the solution of the main challenges in front of the European banking system, the following steps could be outlined:

- 1) The application of a decentralized network approach on EU level by enforcing the proposed network supervision model, which in fact will significantly improve the cooperation and coordination between the national supervisory authorities.

2) Analyzing and understanding the functioning of the banking system as a whole by treating it as complex network structure. While thinking about the banking market and the supervisory institutions as a set of different players and their behavior, we miss an important characteristic which is defined by their interaction between each other in the system. When thinking about the financial market as a system in which different sub-systems are interacting: banking system, national supervisory systems, EU supervisory system, etc, we can see that this is a complex multilayer network of networks. Such structures possess characteristics, not common to its components. A simulation model is presented, showing the bank system behavior in times of crisis. The model reveals that the stability of the system depends not only on the individual bank's stability, but also on the intensity and the size of interbank connections, i.e. how integrated the banking market is.

3) Enhancing the development of the European program for Critical Infrastructure Protection (EPCIP) by defining the banking system as a high-level economic infrastructure, given its fragility and its important role in the economy. By using the CIP paradigm we can outline a framework model which gives a new angle to the approaches for ensuring financial stability.

## Conclusions générales

Ce travail est une tentative de répondre à la nécessité de proposer des moyens de transformation de la structure du système bancaire qui fonctionne avec effet différé (et gestion différée), en un système d'autorégulation opérationnelle (système de systèmes) fonctionnant quasiment en temps réel. Cette transformation accroîtrait la stabilité et l'efficacité du système. Ce travail vise ainsi à promouvoir l'application d'approches et d'outils novateurs pour transformer le système bancaire.

La nouvelle organisation unifiée de supervision bancaire, proposée par la Commission Européenne, le nouveau système d'assurance-dépôts paneuropéen et le cadre européen commun pour la restructuration et la réorganisation des institutions peuvent être efficaces seulement à haut rendement. Pour réaliser la transformation nécessaire du système bancaire, il serait approprié de fournir presque en temps réel de l'information opérationnelle courante à l'instance de supervision bancaire européenne centralisée sur les mesures à prendre au niveau de l'architecture bancaire et sur les besoins de reconstruction de recapitalisation. Il serait également opportun de permettre à la supervision bancaire européenne centralisée d'exercer ses fonctions d'un maillage réseau centrique en réponse au changeant dynamiquement de la structure du réseau des banques interdépendants.

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## **Annex 1 – Review of the supervisory and regulatory structures in the EU Member States**

This appendix presents a description of the current supervisory authorities in the Member States of the European Union and more specifically focuses on the major changes in the supervisory architectures, which came after a similar analysis carried out by the ECB in June 2003.

### **Austria**

Since 2002, in Austria there are two supervisors: Oesterreichische Nationalbank (OeNB) and Finanzmarktaufsichtsbehörde (Financial Market Authority (FMA)), which is an independent institution, established by law and constitutes a separate legal entity. Financial Market Authority oversees investment funds, investment services providers, insurance companies, funds for labor compensation, pension funds, companies traded on the stock exchange and stock markets themselves. Since 2008, the Oesterreichische Nationalbank (OeNB) is the entirely responsible for banking supervision, performs on-site inspections, provide expertise and is responsible for processing the data from supervisory reports on the basis of which it regularly assesses the risk profile of banks.

Supervised entities are required to provide regular information on their activities, its profitability and the risks (supervisory statistics) to the OeNB, where the data are then processed and reviewed.

As for the interaction between different institutions, Financial Market Committee - an independent institution provides a platform for coordination between all institutions responsible for the stability of financial markets.

### **Belgium**

After the merger of the Office de Contrôle des Assurances / Controledienst voor de Verzekeringen (Insurance Control Office) and Commission Bancaire et

Financière / Commissie voor het Bank - en Financiewezen (Banking and Finance Commission), which completed in January 2004, now in Belgium exists a single, unified supervisor. It is called Commission bancaire, financière et des assurances / Commissie voor het Bank, Financie en Assurantiewezen (CBFA).

The Commission has powers to regulate and supervise credit institutions, investment firms, securities markets, companies, securities settlement and clearing institutions, collective investment schemes (CIS), insurance companies, insurance brokers and pension funds. This committee is responsible for overseeing the micro level, while Nationale Bank van België / Banque Nationale de Belgique (NBB) is entrusted with the supervision of the macro-level. Coordination between the two bodies is provided as follows: three members of the Steering Committee of the NBB are involved in managing the CBFA. Moreover, according to the Belgian law, there is a framework for cooperation between the CBFA and the NBB in the face of the Financial Services Authority Supervisory Board. It combines the supervisory board and the board of regents (Council of Regency) on CBFA and NBB, and the Financial Stability Committee (FSC), including the boards of directors of both institutions.

In October 2009, the Governors of the Belgian central bank and a single supervisor (CBFA) announced their common intention to converge the supervisory activities on micro and macro level. Initially it will be created a Committee on systemic risk and subsequently will look for ways to integrate the activities of the two institutions. The ultimate goal is the Belgian central bank to carry out overall supervision of the micro-level, while the new CBFA will be responsible for the financial markets (supervising business practices). Thus will be realized "twin-peaks" model.

## **Cyprus**

Supervisory functions are allocated on the basis of the sectorial model. Central Bank of Cyprus (CBC) is the competent authority responsible for banking supervision: oversees banks and electronic money, ensures the stability of the banking system,

monitor systemic risks and protects depositors. Cooperative credit institutions are supervised and regulated by the Cooperative Societies Supervision and Development Authority (CSSDA), which is the successor to the Department of Cooperative Development, functioning as part of the Ministry of Commerce, Industry and Tourism. Cyprus Securities and Exchange Commission (CySEC) is responsible for the supervision of investment firms, the local collective investment schemes (CIS) and the supervision of the Cyprus Stock Exchange and issuers. It should be noted that the person representing the Governor of the CBC may attend meetings of the board of directors of the CySEC with no voting rights, but have the rights to pose questions for discussion on the agenda to participate in discussions and express opinions. This allows for better coordination and improved exchange of ideas between the CBC and the CySEC. Finally, Insurance Companies Control Service is under the auspices of the Ministry of Finance and supervised insurance sector. In order to better coordination of supervisory activities, national supervisory authorities signed a memorandum of cooperation, which entered into force on 1 January 2003 between three of the four supervisors. Fourth Supervisor, CSSDA, signed the document on November 10, 2003. The purpose of the memorandum is to promote interaction between different sectors by organizing frequent meetings of the "high level" and improve the exchange of information between supervisory authorities.

### **Czech Republic**

On April 1, 2006 came into force framework for unified supervision of financial markets, introducing unified model. Supervisors previously existing, i.e. Securities Commission (SEC), Office for the Supervision of Insurance and Pension Funds (OSIPF) and the Office for Supervision of Cooperative Banks (OSCB) were closed and their functions and personnel transferred to the central bank, Česká národní banka (CNB). CNB is also responsible for supervising the banking, capital markets, insurance industry, pension funds, credit unions and electronic money institutions. As part of this reform Committee for the Financial Market (CFM) was established as an advisory report to the board of CNB for the supervision of financial markets. Of CFM is given

the right to provide comments and recommendations on strategies and approaches to the supervision of financial markets and systemic issues relating to financial markets.

## **Denmark**

In Denmark there is a single supervisor, Finanstilsynet (Danish Financial Supervisory Authority - DFSA), which exists under the auspices of the Minister of Economic and Business Affairs. This body takes on the role as a regulator and supervisor, because it creates a draft regulations, relating to the financial sector and issue decisions. Supervisory functions include both supervision of all financial institutions (credit institutions, mortgage companies, insurance companies, pension funds, insurance brokers, Danish: Labour Market Supplementary Pension, Employees' Capital Pension Fund, Labour Market Occupational Diseases Fund, investment companies and investment funds) and supervision of the securities markets, including companies that are allowed to manage the exchange of securities, securities brokers, brokers involved in the money markets, clearing institutions and companies to register securities.

Cooperation between the DFSA and Danmarks Nationalbank (DNB) is carried out by Financial Business Council, which decides supervisory general issues as well as more specific issues with major implications for individual financial institutions and financial holding companies. In addition, he advises DFSA in issuing regulations. The Council consists of eight members appointed by the central bank, the Ministry of Economic Affairs of users and the various economic and financial sectors. The Secretariat of the Financial Business Council, and the Danish Securities Council and the Danish Pension Market Council, is provided by Danish Financial Supervisory Authority.

In 2005, the DFSA has signed two memoranda of cooperation, to improve coordination in particular with the DNB. The first memorandum was signed by DNB and the Ministry of Finance to support financial stability through information

exchange, consultation and interaction through Steering Committee. The second memorandum was signed by DNB to improve and expand existing coordination practices. It is supplemented by subsequent memoranda in the areas of financial stability, clearing and settlement systems and statistics.

### **Estonia**

Financial supervision is carried out in a uniform pattern of Finantsinspektsioon (Estonian Financial Supervision Authority - EFSA). Estonian Financial Supervision Authority has operational independence, despite the fact that an agency at the Central Bank - Eesti Pank. Joint action is supported by the involvement of the governor and two representatives of Eesti Pank in a six members EFSA Supervisory Council. Estonian Financial Supervision Authority fulfills its obligations to maintain the security and transparency of the financial sector. Besides these two main objectives EFSA is also responsible for monitoring systemic risks and prevent abuses in the financial sector.

### **Finland**

In Finland, the unified model is applied as the supervision is responsibility of the Bank of Finland (Suomen Pankki). This change was imposed in January 2009, when Rahoitustarkastus (Finnish Financial Supervision Authority (FFSA)), until then in charge of banking, and securities sector, merged with Vakuutusvalvontavirasto (Insurance Supervision Authority (ISA)), responsible for the insurance sector. The new Supervisor oversees both banks and insurance companies and pension institutions. It protects the interests of policyholders and depositors, and so promotes safety and efficiency of the insurance and banking markets.

### **France**

In late October 2009 ended the deadline for public consultation on a draft law for the new regulatory body covering the insurance and banking sectors. It is under the control of the French central bank. The new body is called the Autorité de contrôle prudentiel (ACP) and result from the merger of the Commission bancaire, of

the Autorité de contrôle des assurances et des mutuelles (Acam), the Comité des entreprises d'assurance (CEA) and the Comité des établissements de crédit et des entreprises d'investissement (CECEI). The objective was that ACP, existing under the control of the central bank, could ensure stability throughout the French financial sector. Another objective of the reform is to strengthen market surveillance of financial products. It was decided to introduce a structured cooperation between the ACP and the supervisory authority of the financial markets AMF. Autorité de contrôle prudentiel (ACP) has been operational since early 2010.

The framework for financial supervision in France was renewed in 2003 with the aim of improving the efficiency of the national system of financial regulation. This framework has been substantially reorganized and simplified. Financial Security Act, which entered into force on 1 August 2003 on Autorité des marchés financiers (AMF), resulting from the merger of the Commission des opérations de bourse (COB), Conseil des marchés financiers (CMF) and the Conseil de discipline de la gestion financière (CDGF). Autorité des marchés financiers, which is an independent public organization, entity and have financial independence, is responsible for the protection of deposits and orderly functioning of financial markets. In particular, AMF monitors securities transactions and collective investment schemes to ensure compliance with the provision of information to investors. Representative of the Banque de France, appointed by the Governor, is a board member of the Autorité des marchés financiers.

## **Germany**

After the changes that occurred in 2002, in Germany there is already a single supervisor, Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin), which oversees banks, investment companies and insurance companies, providing both stability and normal functioning of the German financial markets and investor protection and consumers. However, Deutsche Bundesbank is heavily involved in the supervision of banks. Deutsche Bundesbank carries out daily monitoring of institutions, which

includes on-site inspection and evaluation of documents, audit reports and annual financial statements. Deutsche Bundesbank also audited and evaluated banking operations to verify compliance with regulatory capital requirements and the adequacy of risk management. To enhance cooperation between the Deutsche Bundesbank and BaFin, was established forum for the supervision of financial markets ("Forum für Finanzmarktaufsicht"). In particular, he coordinates the activities of the Deutsche Bundesbank and BaFin and makes recommendations on issues related to the overall supervision of financial services, which are important for the stability of the financial system. In 2002 an agreement was signed for cooperation on the supervision of credit and financial institutions. Bundesanstalt für Finanzdienstleistungsaufsicht monitor both banks and investment companies in cooperation with the Deutsche Bundesbank, and insurance companies, thereby ensuring on the one hand, the stability and proper functioning of the entire German financial market, and on the other, protecting both investors and users. As for the supervision of the insurance sector should be noted that the BaFin supervises the cross-border insurance companies operating outside the boundaries of a single federal state, while regional supervisors are responsible for the supervision of insurance companies operating within the boundaries of a single federal state, and those which are not of essential economic importance.

On October 24, 2009 agreement was reached between the coalition partners in Germany, under which is planned only Deutsche Bundesbank to be responsible for banking supervision.

### **Greece**

In Greece, a sectorial model of supervision is established. Three different bodies are responsible for supervision of the financial sector. The Bank of Greece is responsible for the supervision of credit and financial institutions, and in particular for: banks, leasing and factoring companies and organizations acting as intermediaries in money transfers and exchanges. Bank of Greece oversee these



organizations monitor their stability, liquidity, adequacy of their internal audit systems, and the concentration of risks affecting them. Hellenic Capital Market Commission (HCMC) is the supervisor of the securities markets: companies engaged in brokerage and investment business firms engaged in the management of collective investment schemes (CIS) or investment portfolios of securities and securities exchanges and derivatives. Hellenic Capital Market Commission is an independent body empowered to take decisions. It is a separate legal entity under the auspices of the Ministry of Economy and Finance. Hellenic Capital Market Commission aims to ensure the proper functioning of the markets and at the same time maintaining and increasing consumer confidence. Bank of Greece is entitled to appoint one of the seven members of the board of HCMC, which is approved by the Ministry of Economy and Finance. Under the leadership of the Ministry of Economy and Finance was founded Committee for Private Insurance Supervision (CPIS), which deals with the Insurance Supervisory.

## **Hungary**

Since 2000 in Hungary operates single supervisor Pénzügyi Szervezetek Állami Felügyelete / Hungarian Financial Supervisory Authority (HFSA), which is a result of the merger of three entities that existed previously - Hungarian Banking and Capital Market Supervision; State Insurance Supervision; and State Pension Supervision. Hungarian Financial Supervisory Authority supervises credit institutions, investment companies, insurance companies and pension funds. HFSA structure undergo further changes in 2003. Till then the President of the HFSA was responsible for the management of the organization and its supervisory functions. Now the supervisory functions are delegated to the five-member supervisory board. The management function is the responsibility of the Director.

Hungarian Financial Supervisory Authority cooperates with the central bank, Magyar Nemzeti Bank (MNB) and the Ministry of Finance based on the tripartite agreement signed in September 2004, this agreement includes the establishment of

the Financial Stability Committee needed to better coordination of actions to maintain financial stability. The Committee shall meet quarterly to discuss and examine important issues relating to financial stability, including: experiences and observations of HFSA and MNB on the supervision and inspection issues related to payment and settlement systems, deposit insurance and consumer protection; issues related to market competition between firms, assessment of the causes that led to the crisis, which could be potentially dangerous to the system of financial intermediation. The Committee may issue press releases and statements on the system of financial intermediation.

Furthermore, between the HFSA and the central bank there are two additional bilateral agreements. More precisely, between them there is a cooperation agreement, which entered into force in August 2006, aimed at improving and expanding coordination in the event of a financial crisis.

## **Ireland**

New supervisory regime was introduced in Ireland in 2003 with the restructuring of the Central Bank and Financial Services Authority of Ireland (CBFSAI). The Irish Financial Services Regulatory Authority (IFSRA) was established as an independent body within the CBFSAI. From May 2003 IFSRA was responsible for supervising the entire financial services sector in Ireland with the exception of pension funds. It also plays an important role in ensuring consumer protection. It is important to note that IFSRA cooperate closely with CBFSAI in its task of maintaining overall financial stability. Therefore, the manager of CBFSAI has many powers: he must consult financial regulator as his consent is necessary regarding questions relating to the stability of the Irish financial system, it has the power to authorize employees of CBFSAI to investigate (including inspections) licensed credit institutions, cooperative institutions specializing in construction lending (building societies), savings banks, licensed securities exchanges, licensed investment intermediaries (authorised investment business firms) and licensed CIS, he may, according to his

appointment, issue guidelines to the IFRSA on the policies and principles, which IFRSA should follow in performing the functions of the Financial Services Authority of Ireland.

In June 2009 the minister of finance in Ireland announced the government's agreement to establish a single fully integrated regulatory institution called the Central Bank of Ireland Commission. The new organization will replace the current structure Central Bank and the Financial Services Regulatory Authority. The new Central Bank Commission will be chaired by the Governor of the Irish Central Bank and will be responsible for the supervision of individual financial institutions and the maintenance of financial stability. The work on consumer protection is set up as a separate agency (National Consumer Agency), which assumes also the antitrust function.

## **Italy**

The responsibility for the supervision and regulation of the financial sector in Italy is given to four different bodies: Banca d'Italia; Commissione Nazionale per le Società e la Borsa (Securities Commission (CONSOB)), Istituto per la vigilanza sulle assicurazioni private e di interesse collettivo ( Insurance Supervisory Institute (ISVAP)) and the Commissione di vigilanza sui fondi pensione (Pension Fund Supervisory Commission (COVIP)). This supervisory model is the result of the division of responsibilities for the banking sector and that of the securities: Banca d'Italia has been given the supervision of credit institutions, investment firms and other financial intermediaries; CONSOB is responsible for transparency and business practices of investment companies. CONSOB also has supervisory powers with respect to the securities markets, the manner of disclosure and completeness of the information provided by issuers of financial instruments, market abuse and insider trading. However, Banca d'Italia is responsible for the supervision of these markets, such as the market for government securities and interbank deposits, in order to ensure the overall efficiency of the market and established business practices. Additionally, with

the consent of CONSOB, Banca d'Italia regulates and supervises post-trading infrastructure (clearing and settlement). Insurance companies are under the supervision of ISVAP, aiming to ensure both stability and transparent functioning of insurance companies. Pension funds are overseen by COVIP, and Ufficio Italiano Cambi (Italian Foreign Exchange Office (UIC)) responsible for the verification of financial firms on compliance with laws against money laundering.

Comitato interministeriale per il credito e il risparmio (Inter-ministerial Committee for Credit and Savings (CICR)) should also be mentioned to complete the picture of financial supervision in Italy. It is a collective body composed of the ministers responsible for finance and economic affairs and chaired by the Minister of Economy and Finance. Governor of the Banca d'Italia attend its meetings. Inter-ministerial Committee for Credit and Savings is responsible for issuing general guidelines for supervision in the areas of lending, and the protection of savings. Inter-ministerial Committee for Credit and Savings may decide on some specific matters within its sphere of competence. The Law on the protection of savings and financial market regulation, approved in late 2005 requires some changes in the supervisory framework. Obligation of the implementation of competition law with regard to the banking sector was transferred from Banca d'Italia to Autorità garante della concorrenza e del mercato (AGCM). Investment products offered by banks are subject to the same rules and control (by Consob instead of Banca d'Italia), applicable to other intermediaries. Cooperation between supervisors was reinforced by the obligation to draw up plans for coordination and exchange of information.

## **Latvia**

From 1 July 2001, the supervision of the whole financial market in Latvia is carried out by a single independent body, Finanšu un kapitāla tirgus komisija (Finance and Capital Market Commission (FKTK)), which supervises credit institutions, insurance companies and brokers, issuers of financial products investment companies, organizers of regulated markets (Riga Stock Exchange), Latvian Central

Depository, companies engaged in investment management and investment funds and private pension funds and government-sponsored pension scheme. The main objectives of FKTK are twofold: 1) ensuring the protection of investors, depositors and policyholders, 2) promoting the development and stability of the market. Finance and Capital Market Commission also manages the fund to guarantee bank deposits and funds to protect the insured. Finance and Capital Market Commission shall cooperate with the Bank of Latvia and Ministry of Finance. Furthermore, FKTK assist authorities responsible for the prevention of money laundering (Office for the Prevention of Laundering of Proceeds Derived from Criminal Activity). In December 2003, Bank of Latvia and FKTK signed a cooperation agreement to improve the exchange of information, the practice of joint inspections and sharing efforts for maintenance of information technology.

### **Lithuania**

The objectives of the financial supervision in Lithuania are distributed according to the sectoral model. There are three supervisors: Lietuvos bankas (NCB); Vertybinių popierių komisija (Latvian Securities Commission - Lithuanian Securities Commission) and Draudimo priežiūros komisija (Supervisory Commission insurers - Insurance Supervisory Commission (ISC)). Lietuvos bankas supervises the banking sector, issues and revokes licenses of credit institutions, establishes principles and formats of financial accounting and reporting. Lithuanian Securities Commission oversees the securities market as a whole in order to maintain and increase its efficiency, protects the interests of investors and the establishment of fair trade practices and competition. The insurance sector is supervised by the Insurance Supervisory Commission, renamed as a result of reform, which became in 2004 the Insurance Supervisory Commission aims to ensure the reliability, efficiency, safety and stability of the insurance system and at the same time protects the interests of the insurance industry-related parties.

In 2000, the Bank of Lithuania, Lithuanian Securities Commission and the Insurance Supervisory Commission signed a memorandum of cooperation to improve the coordination and exchange of information relating to institutions supervised.

The Commission for the Regulation of the Business of Financial Institutions and Coordination of Supervision was created in 2003 in order to ensure more effective cooperation between supervisors. The Commission includes representatives from each of the three supervisors, and representatives of the Parliamentary Committee on Budget and Finance and the Ministry of Finance.

### **Luxembourg**

In Luxembourg there are two supervisors: Commission de Surveillance du Secteur Financier (Financial Sector Supervisory Commission (CSSF)) and the Commissariat aux Assurances (Insurance Commission (CoA)). Financial Sector Supervisory Commission, in operation since 1 January 1999, is a body distinct from the Banque centrale du Luxembourg. It acts as a supervisor of the entire financial sector, overseeing a wide range of businesses such as banks, investment firms, UCITS, electronic money institutions, securitization products, pension funds, investment companies, venture capital management companies and securities exchanges. As for the supervision of insurance and reinsurance companies, the competent authority is the Commissariat aux Assurances (Insurance Commission (CoA)). It is a separate public entity and operates under the guidance of the Ministry of Finance. While the central bank is not directly involved in the supervision process, it plays a role in maintaining financial stability through its membership in the ESCB.

### **Malta**

Since 2002 the single supervisory model is used in Malta. Malta Financial Services Authority (MFSA), performs functions that were previously performed by the Malta Financial Services Centre, it also adopted the regulatory functions that were previously the responsibility of the Central Bank of Malta (CBM) and Malta Stock Exchange. Malta Financial Services Authority regulates and supervises all banking

activities, activities related to securities or insurance, and also acts as the administering authority of the national company register. Malta Financial Services Authority licenses and oversees securities exchanges. The objectives of the activity of the MFSA generally include the protection of investors, fair competitive practices, the availability of consumer choice, and encouragement to use the highest possible standards of conduct in the financial services industry. In 2003, the MFSA and CBM signed a memorandum on cooperation, which aims at improving the exchange of information between the two institutions and the creation of an Advisory Committee, which meets at frequent intervals or ad-hoc, if necessary, for exchange of different perspectives.

### **The Netherlands**

The Netherlands had introduced institutional reform based on the separation between the supervisory process and issues related to business practices. De Nederlandsche Bank (DNB), which in 2004 merged with the Pensions and Insurance Supervisory Authority Foundation, Pensioen & Verzekeringskamer (PVK), is responsible for the supervision of financial institutions, while Autoriteit Financiële Markten, Authority for the Financial Markets (AFM) is responsible for compliance with prudent business practices and the transparency and accuracy of information available on the market.

### **Poland**

Since January 2008, the banking supervision was transferred from the Polish Central Bank to the Polish Financial Supervision Authority (PFSA) - unified financial supervisory authority, built in 2006, which was formally responsible with the maintenance of financial stability. Officially, the central bank took over the function for preserving the financial stability in 2008 after the creation of the Financial Stability Committee. Recently there are some discussions on how effective the implementation of the unified supervisory architecture is.

## **Portugal**

In Portugal, there are three different supervisors: the Central Bank / Banco de Portugal (BdP); Commission for securities regulation / Comissão do Mercado de Valores Mobiliários (CMVM) and the Insurance Institute / Instituto de Seguros de Portugal (ISP). Portuguese supervisory structure is organized as a combination of the sectoral model (in terms of insurance / pension funds and credit institutions) and partially integrated model (with regard to organizations operating on the securities markets).

Supervision of the banking and insurance sectors (including pension funds) is assigned to BdP and ISP in that order. Cross-sectoral supervision over the activities of financial intermediaries in the securities markets is assigned to the CNMV, and oversight on a micro-level is assigned to the central bank (including the supervision of investment firms and other financial companies).

The three supervisors in Portugal cooperate by Conselho Nacional de Supervisores Financeiros (National Council of Financial Supervisors). This high-level committee was established in 2000 to coordinate national strategies to increase the effectiveness of supervision in the areas of banking, capital markets and insurance. However, it has no direct powers over financial institutions. Bilateral memoranda of cooperation between supervisory authorities provide the framework for the coordination of their daily tasks.

## **Slovakia**

In Slovakia, in line with the reform came into force on 1 January 2006, the central bank, Národná banka Slovenska (NBS), is responsible for overseeing the entire financial market in the country. Národná banka Slovenska has extensive supervisory powers and responsibilities because it performs functions that were previously split between two separate supervisors: NBS, responsible for the banking sector, and Úrad pre finančný trh, Slovakian Financial Market Authority (SFMA), body responsible for supervising the insurance sector and capital markets. Národná banka Slovenska have



to maintain the stability of the financial system as a whole, and to ensure safe and stable operation of the financial markets, ensuring the protection of their customers and the general compliance with competition law. In order to support the functioning of the NBS, its board was expanded to include experts on capital markets, insurance and pensions.

### **Slovenia**

In Slovenia, the financial supervision functions of are carried out by three supervisors according to the sectoral model. National central bank, Banka Slovenije, is responsible for the supervision of banks and savings banks (including electronic money institutions), as well as other persons under the Banking Act (Law on banking). Securities Market Agency, Agencija za trg vrednostnih papirjev (SMA), is responsible for overseeing the securities sector (ie companies that perform broking, investment funds, pension funds). Insurance Supervision Agency, Agencija za zavarovalni nadzor (ISA), responsible for supervising the insurance market (companies engaged in insurance and reinsurance, insurance agencies, companies that perform brokerage of insurance products and insurance agents and brokers) and of pension companies. Three supervisors are legally and organizationally differentiated but are legally obliged to cooperate in carrying out their activities and exchange information according to the rules for mutual cooperation between the supervisory authorities (Pravilnik o medsebojnem sodelovanju nadzornih organov), issued by the Minister of Finance. As for financial conglomerates, supervisors may designate a coordinator to perform additional supervisory tasks according to the Law on Financial Conglomerates (Law on financial conglomerates).

### **Spain**

In Spain, three different bodies perform supervisory functions under the sectoral model. National central bank (Banco de España - BE) is responsible for overseeing all credit institutions and aims to ensure the stability of the banking system; Comisión Nacional del Mercado de Valores (National Commission for the

Securities Market (CNMV)) is responsible for supervision of the Spanish securities markets and intermediaries operating on them. It aims at ensuring market transparency and investor protection. Directorate General Insurance and Pension Funds, which is part of the Ministry of Finance is responsible for the oversight of private insurers and reinsurers, insurance firms and pension funds.

The legal framework includes agreements on cooperation between supervisors. In 2004 BE signed a cooperation agreement with the CNMV and Directorate General Insurance and Pension Funds, in order to define the appropriate competences and to build frameworks for information exchange and settlement of issues concerning all supervisors.

Agreement for cooperation on financial stability in order to prevent and manage crises with potentially systemic consequences was signed by the Ministry of Economy and the three supervisors in 2006, this agreement established a Financial Stability Committee (Comité de Estabilidad Financiera), composed of senior employees of the Ministry and each of supervisors. The committee discusses the regulations relating to financial stability and the implementation of the abovementioned cooperation agreements.

## **Sweden**

Since 1991 Finansinspektionen, Swedish Financial Supervisory Authority (SFSA) is a single integrated regulatory authority responsible for the supervision of the banking and insurance sector and securities market in Sweden. The main tasks of the SFSA are promoting the stability and efficiency of the financial system and ensure effective consumer protection. In June 2005, the Ministry of Finance (Regeringskansliet - Finansdepartementet), Finansinspektionen and Sveriges Riksbank signed a cooperation agreement on the issues of financial stability and crisis management. The agreement includes the issuance of guidelines for consultation and exchange of information between the three organizations to improve financial stability and leadership in times of crisis. The objective of the agreement is to

regulate the contact between the parties (which has existed in informal settings) and to improve the exchange of information in order to reduce duplication of activities.

### **England**

From 1 December 2001, according to Financial Services and Markets Act (FSMA) 2000, Financial Services Authority (FSA) is the only financial supervisory authority in the United Kingdom who is responsible for the entire financial sector. Financial Services Authority is an independent non-governmental body. It is entirely funded by the financial sector, but is accountable to the Chancellor of the Exchequer (HM Treasury), and through him to Parliament. In recent years the FSA expanded its powers, took responsibility for mortgage regulation in October 2004 and for the regulation of general insurance in January 2005, Bank of England (BoE) is responsible for ensuring monetary and financial stability. It oversees the financial infrastructure, and in particular payment systems in order to reduce systemic risks. Financial Services Authority cooperates with HM Treasury and BoE in maintaining financial stability. For this purpose, three bodies have signed a memorandum of cooperation, which established a Standing Committee. This committee meets monthly to discuss both specific cases of interest, and other events relating to overall financial stability. In addition, the Deputy Governor of BoE (who is responsible for financial stability) is a non-executive director on the board of the FSA. At the same time the FSA's chairman is also a member of the Court of Directors of the Bank of England.

### **Romania**

Financial supervision in Romania is organized according to the sectoral model. National central bank, Banca Națională a României (BNR), which is an independent public institution, also plays the role of the banking supervisor. Some of the key features of BNR include licensing, regulation and supervision of credit institutions, as well as care for the smooth operation of the payment systems in order to ensure financial stability. In 2006, BNR was also assigned the monitoring and supervision of financial institutions engaged in lending.

Romanian National Securities Commission, Comisia Națională a Valorilor Mobiliare (CNVM), which is an autonomous administrative body, is responsible for the regulation and supervision of capital markets, commodity markets and regulated markets of financial derivative instruments and related organizations.

Romanian Insurance Supervisory Commission, Comisia de Supraveghere a Asigurărilor CSA, which is a specialized autonomous administrative body, is responsible for the licensing and supervision of insurance companies, reinsurance companies, insurance brokers and reinsurance, and other firms operating in the field of insurance and reinsurance business.

Supervisory Commission of the Private Pensions System, Comisia de Supraveghere a Sistemului de Pensii Private (CSSPP), was established in 2005 as an autonomous administrative body responsible for the regulation, coordination, supervision and control over the activities of the private pension system. Supervisory Commission of the Private Pensions System is responsible for the supervision of pension funds. On March 10, 2006 BNR, CNVM and CSA signed a new memorandum of cooperation to improve the stability of the financial system as a whole and its constituent parts. The memorandum includes quarterly tripartite meetings at the level of manager of each of the three authorities as Secretariat of the Financial Stability Department of the BNR. Memorandum 2006 creates five permanent specialized technical committees (Financial Stability Committee, Supervision and Control Committee, Regulatory Committee, Payment Systems Committee and Financial Statistics Committee).

## Annex 2: Financial supervision under the Central bank

Supervision in the Central Bank	Macro-prudential supervision	Banks	Insurance	Investment companies	Pension funds	Issuers, exchanges (business practices)	Consumer protection	Additional information
<b>Belgium</b>	yes	yes	Yes	yes	yes	CBFA	CBFA	
<b>Germany</b>	yes	yes	yes (on a consolidated basis)	BAFIN	BAFIN or the federal authorities	BAFIN	BAFIN	
<b>Estonia</b>	yes	yes	yes	yes	yes	yes	yes	EFSA is an agency in the central bank
<b>Ireland</b>	yes	yes	yes	yes	yes	NCA	NCA	
<b>Italy</b>	yes	yes	ISVAP	yes	COVIP	CONSOB AGCM (for banking competition)	yes CONSOB	
<b>Slovakia</b>	yes	yes	yes	yes	yes	yes	yes	
<b>Finland</b>	yes	yes	yes	yes	yes	yes	yes	FIN-FSA is part of the central bank
<b>France</b>	yes	yes	yes	AMF	yes	AMF	yes AMF	ACP is part of the central bank
<b>The Netherlands</b>	yes	yes	yes	yes	yes	AFM	AFM	
<b>Czech Republic</b>	Yes + CFM	yes	yes	yes	yes	yes	yes	CFM is an advisory body, which reports to the board of the central bank

### Annex 3: DEA Methodology

That there are  $n$  DMUs (banks), each producing  $s$  different outputs using  $r$  different inputs. The efficiency ratio is calculated (Ismail, 2004) by the following way:

$$E_l = \frac{\sum_{i=1}^s u_i y_{il}}{\sum_{j=1}^r v_j x_{jl}} \quad \text{Equation 1}$$

where:

$E_l$  = relative efficiency of the DMU

$s$  = number of outputs produced by the DMU

$r$  = number of inputs employed by the DMU

$y_i$  = the  $i$ -th output produced by the DMU

$x_j$  = the  $j$ -th input employed by the DMU

$u$  =  $s \times 1$  vector of output weights and

$v$  =  $r \times 1$  vector of input weights.

$i$  runs from 1 to  $s$  and  $j$  runs from 1 to  $r$ .

Rewritten in the form of fractional programming and then transformed into a linear programming as done by Charnes et al. (1978), we have:

## Equation 2

$$\max E_l = \sum_{i=1}^s u_i y_{il}$$

subject to:

$$\sum_{j=1}^r v_j x_{jl} = 1$$

$$\sum_{i=1}^s u_i y_{im} - \sum_{j=1}^r v_j x_{jm} \leq 0, m = 1, \dots, n.$$

$u_i, v_j \geq 0$ .  $u$  and  $v$  are small but positive quantities. The first constraint ( $v_j x_{jl} = 1$ ) guarantees that it is possible to move from a linear programming to a fractional programming as well as from a fractional programming to a linear programming (Bowlin, 2002). Equation 2 is constructed under the assumption of constant returns to scale.

However, the CCR model shown by Equation 2 is only appropriate when all decision making units (DMUs) are running at an optimal scale, and this requires the DMUs to operate at the flat portion of the long run average cost (LRAC) curve. In practice, some factors may prevent a DMU from operating at optimal scale, such as financial and legal constraints, imperfect information etc. Coelli (1996) highlighted that the use of the CRS specification when some of the DMUs are not running at optimal scale will result in measures of technical efficiency which are mixed up with scale efficiency. To overcome this problem, Banker et al (1984) suggested their model (known as the BCR model). It improved the CCR model by introducing a variable that

represents the returns to scale. The BCR model allows a calculation of technical efficiency that is free from the scale efficiency effects.

In the BCR model, the problem formulation is written as:

Equation 3

$$\begin{aligned} \max E_l &= \sum_{i=1}^s u_i y_{il} - c_l \\ \text{subject to:} \\ \sum_{j=1}^r v_j x_{jl} &= 1 \\ \sum_{i=1}^s u_i y_{im} - \sum_{j=1}^r v_j x_{jm} - c_l &< 0, m = 1, \dots, N \end{aligned}$$

The parameter  $c_l$  is unconstrained in sign. It indicates the various possibilities of returns to scale.  $c_l > 0$  means increasing returns to scale and  $c_l = 0$  implies constant returns to scale. Finally,  $c_l < 0$  implies decreasing returns to scale. This model forms a convex hull of intersecting planes which envelop the data points more tightly than the CRS model. Therefore, it enables technical efficiency scores to be greater than or equal to those obtained under the CRS model.



## Annex 4: Reliability and Hypothesis testing

We use the Cost Income Ratio (Operational Expenses / Gross Income) and the Operational Profit Margin (Operational Profit / Gross Income).

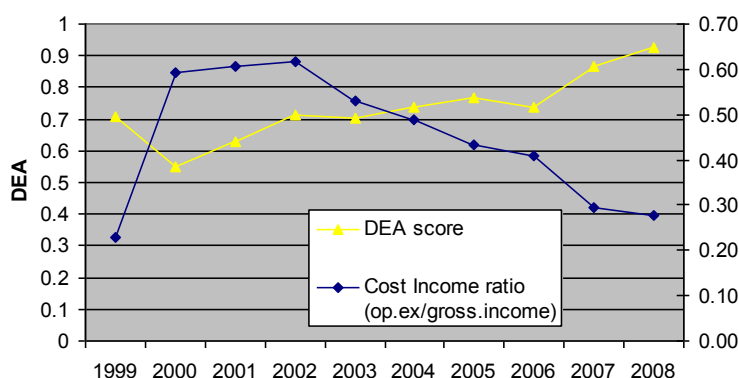


Chart 3.3 – DEA scores vs. Cost Income ration

Correlations				
		DEA trend	Cost Income Ratio (op. ex/gross. income)	Operational Profit Margin (op/profit/gross.income)
DEA_trend	Pearson Correlation	1	-.707*	-.855**
	Sig. (2-tailed)		.022	.002
	N	10	10	10
Cost Income Ratio (op. ex/gross.income)	Pearson Correlation	-.707*	1	.609
	Sig. (2-tailed)	.022		.062
	N	10	10	10
Operational Profit Margin (op/profit/gross.income)	Pearson Correlation	-.855**	.609	1
	Sig. (2-tailed)	.002	.062	
	N	10	10	10

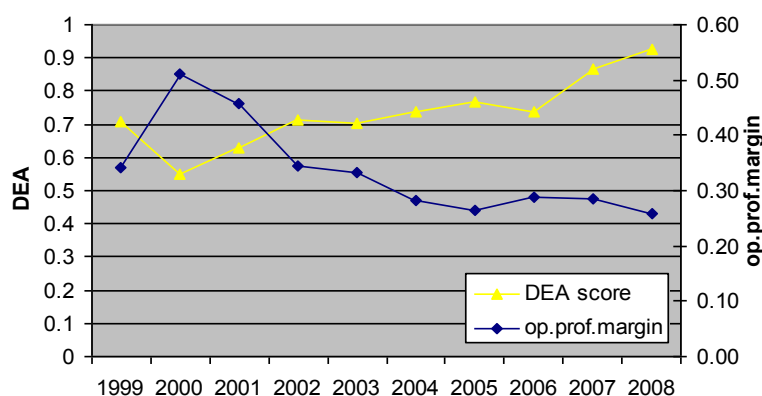
\*. Correlation is significant at the 0.05 level (2-tailed).

\*\*. Correlation is significant at the 0.01 level (2-tailed).

Table 3.2 – Correlations

From Chart 3.3 and Table 3.2 we see that the DEA score is negatively correlated with the Cost Income Ratio. This ratio is one of the most analyzed accounting indicators for financial and cost efficiency. It shows the change in the operating costs, driven by the change in the volume of production (gross income). The decrease means that banks are improving their technical efficiency over the years as the operating costs are decreasing relatively in relation to the gross income.

This could be an effect of improvement of the cost efficiency by eliminating excessive staff expenses and optimising other costs, or increase of the income while the costs remain unchanged.



*Chart 3.4 – DEA scores vs. Operational Profit margin*

We also see that the DEA score is negatively correlated with the Operational Profit Margin (*Chart 3.4* and *Table 3.2*). This could question the reliability of our results. But we must not forget that the higher interest rate margins are considered to be an indicator for a not well developed banking system. Given that the Cost Income Ratio and the Operational Profit Margin are both decreasing, this means that while the cost efficiency is improving, the interest rate margin is shrinking and the gross income is growing more rapidly than the operational profit. This is due to the increasing market competition and higher financing costs. This shows that for maintaining their profit growth rates the banks could no longer rely on the higher interest margins because of the market saturation and are expanding their portfolios relying on its scale, which leads to higher interest costs.

### **There is a role for privatization?**

By the K-S test, we see that the distributions are normal and we can use a parametric test to test the hypothesis. Due to the small sample size we use T-test.

We test two hypotheses:

H0: efficiency of privatized banks = efficiency of Bulgarian banks (no significant difference between the effectiveness of local banks and privatized banks).

H0: efficiency of privatized banks and banks with foreign capital = efficiency of Bulgarian banks (no significant difference between the effectiveness of local banks and banks with foreign capital).

**One-Sample Kolmogorov-Smirnov Test**

		BG Banks	Privatized	Priv Green
N		10	10	10
Normal Parameters <sup>a,b</sup>	Mean	.8273	.8752	.8781
	Std. Deviation	.06105	.07149	.07107
Most Extreme Differences	Absolute	.149	.150	.239
	Positive	.131	.101	.125
	Negative	-.149	-.150	-.239
Kolmogorov-Smirnov Z		.470	.474	.757
Asymp. Sig. (2-tailed)		.980	.978	.616

a. Test distribution is Normal.

b. Calculated from data.

		Paired Differences				t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	BG_banks - Privatized	-.04787	.07348	.02324	-.10043	.00469	-2.060	.069
Pair 2	BG_banks - Priv_Green	-.05080	.08006	.02532	-.10807	.00647	-2.007	.076

We can reject both null hypotheses (Sig. <0,10).

**Is there an integration of European financial markets?**

**One-Sample Kolmogorov-Smirnov Test**

		BG_DEA_score	EU_DEA_core
N		6	6
Normal Parameters <sup>a,b</sup>	Mean	.7737	.9428
	Std. Deviation	.10020	.04835
Most Extreme Differences	Absolute	.169	.267
	Positive	.169	.186
	Negative	-.160	-.267
Kolmogorov-Smirnov Z		.413	.655
Asymp. Sig. (2-tailed)		.996	.785

a. Test distribution is Normal.

b. Calculated from data.

By the K-S test, we see that the distributions are normal and we can use a parametric approach for testing the hypothesis. Due to the small sample size we use T-test.

H0 states that there is no significant difference between the average levels of efficiency of Bulgarian and European banking markets. (BG DEA result = EU DEA result).

Considering the results, we may reject the null hypothesis (Sig. <0,05).

**Paired Samples Test**

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	BG_DEA_score - EU_DEA_core	-.16914	.06223	.02540	-.2344	-.10384	-6.658	5	.001

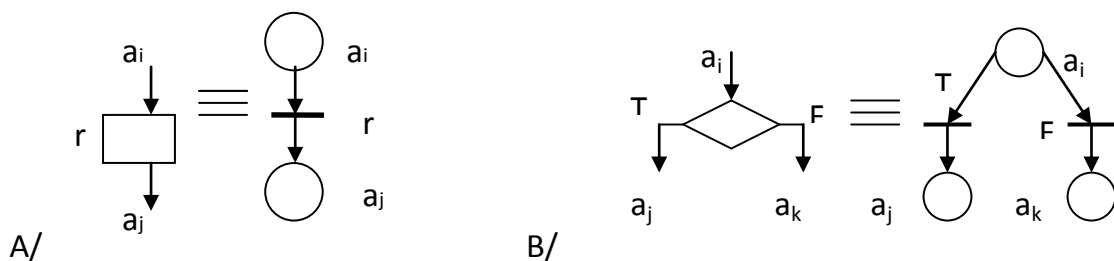
## Annex 5 – Petri nets – tools for modeling and analysis

Petri nets (PN) are formal and graphical appealing language which is appropriate for modeling systems with concurrency and resource sharing. It is the first time a general theory for discrete parallel systems was formulated.

When a PN is being created commonly one of the following methods are used:

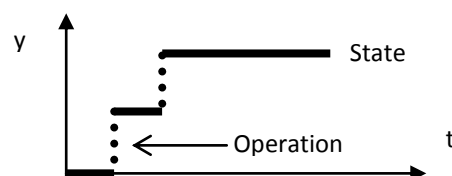
- When a cause-resulting dependency is being modeled the following accordances are being used: place - condition; transition - operation (conditions from which it depends it's realization are inputs and when they are fulfilled this is indicated with according number of marks at the place). The outputs for a transition are equal to the number of conditions that can cause the execution of an operation that is represented by this transition); activation of transitions – change in the condition.

- When block-diagram is build in order to obtain a PN the following accordances are being used:



- When the table of transitions and outputs of a finite state machine is composed there is algorithm for obtaining the PN of the machine.

- When time sequence is set transition to a PN is shown of the figure below:



## Properties of the Petri Nets

- *Safety*. The position in the net is safe if the number of the marks in it is not greater than one. The Petri Net is safe if all positions in the net are safe. The safe nets are used for analysis and development of digital schemes build at the base of logical elements.

- *Boundedness*. The safety is a case of the property boundedness. The position  $k$  is safe or  $k$  bounded if the number of marks in it can't be greater than the integer  $k$ . The position is bounded if it is  $k$  safe and PN is bounded if all its position are bounded.

- *Preservation*. The Petri Net in which never marks are created or destroyed (their count stays constant).

- *Activity*. The net can be interlocked when two processes use shared resources. The processes use the shared resource and take it, use it and release it. The system blocks if no process can be executed. The transition is active if it isn't blocked.

- *Reachability*. The problem of reachability examines if a marking is reachable or can be reached after a certain sequence of executed transitions from a certain initial marking. Also the object of examination can be a test for a presence of a state in which a position or a group of positions contain number of marks greater than or equal to one.

- *Order of operations*. This method for analysis is not based on the content of the positions. It's based on the order of execution of the transitions. For example if the sequence  $t_2t_4$  is in the reachability graph of the PN.

- *Simultaneousness and conflict* – If in a network there is a place with more than one output transitions, the place is called conflict place. It's necessary to be taken a decision of which of this output transitions to be activated.

Therefore, the modeling of an operation is sequence of activating the transitions, which leads from exact initial marking to desirable reachable marking.

### **PN analysis**

The PN origin has to be analyzed in order to ensure correct modeling of the system behavior. The characteristic questions which can be asked about PN model are the following:

- (1) Are the PN safe? The safe PN are these with no more than 1 token in every place in the net.
- (2) Are the PN limited? Nets with limited by K token number in every one place are called k-limited. If the net is k-limited for some k and the k value is unknown, it is named only limited. The safe net is the 1-limited.
- (3) Is the number of token saved? PN are conservative if the token number in the net is saved. This means that the number of the input arcs in every active transition is equal to the number of the output arcs. If the tokens represent resources they have to be saved until resources are created or reduced/destroyed.
- (4) Which transition in PN are live and which are non live? The transition is live if it is potentially active for some accessible markings. -The transition is non live if there is no following activations of transitions, which allow it.

The analysis of PN was made by Reachability Graph ( RG ). The basic method for PN analysis:

- Graph which nodes are the markings of PN( $M_i$ ) and which arcs are the transitions, after their activation the result is new marking of the net.
- Every marking represents the condition of all of the net nodes.

- The basic nod is marked with start token.
- The nod X is a tree, additional nods are added to all of the markings, so that they are directly accessible to the nod x marking.
- When in one or more than one nods marks are accumulated, for the number of tokens in this condition the special symbol  $\omega$  is used.
- $\omega$  is a value which can be overbearing big.
- $\omega + a = \omega$ .  $\Omega - a = \omega$ ,  $a < \omega$  for all natural numbers a.

## Conclusion

1. Our analysis outlines the opportunity for constructing a common model for Network approach for realization of the financial transformation and ensuring stability and efficiency of the global financial system

2. Using the PN network as a mathematical model shows advantages related to mathematical analysis of critical situations in terms of viability, accessibility and narrowness.